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THE AQUATIC RESOURCES OF THE HAWAIIAN ISLANDS.

Part III.—MISCELLANEOUS PAPERS.

Based on Collections and Investigations made by the United States Fish Commission Steamer Albatross in 1902, under the direction of

DAVID STARR JORDAN and BARTON WARREN EVERMANN.

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Sabellaria setosa ... 1180

BIRDS OF LAYSAN AND THE LEEWARD ISLANDS, HAWAIIAN GROUP.

By WALTER K. FISHER.

PROCELSTERNA SAXATILIS: NECKER ISLAND TERN. ONE HALF NATURAL SIZE.

JULIUS BIEN & CO. N.Y.

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INTRODUCTION.

From March to August, 1902, the U. S. Fish Commission steamer *Albatross* was engaged in deep-sea explorations among the Hawaiian Islands. During May these investigations were extended westward along the chain of reefs and islets which reach out from the main group in the direction of Japan. I have referred to these as the Leeward chain. The Hawaiian group can very conveniently be divided into two parts—the Windward Islands, including the main large members from Hawaii to Niihau and Kauai, and the Leeward Islands or "chain," comprising the westward extension, sometimes known as the "Bird Islands." Beginning at the east, they include Bird Island, Necker, French Frigate (or Brooks) Shoals, Gardner, Laysan, Lisiansky, Midway, Cure, and Morell, together with numerous sunken reefs.

The *Albatross* went only as far as Laysan, lat. 25° 42′ 14″ N., long. 171° 44′ 06″ W., about 800 miles from Honolulu. The vessel arrived here May 16 and remained till the 23d. On the return voyage she stopped at French Frigate Shoals, Necker and Bird islands, but a landing was made only on Necker. During the stay at Laysan Mr. John O. Snyder and the writer were detailed by the naturalist in charge of the expedition, Dr. Charles H. Gilbert, to make observations on the bird life of the island and collect such specimens as seemed desirable.

The results of this week's investigations on the island—one of the most remarkable bird islands in the world—make up the greater part of the following report. I have included also notes gathered at other islands of the Leeward chain visited, besides the few published records for those we did not visit. This makes the paper fairly complete for the Leeward group. The main Hawaiian Islands are not touched upon.

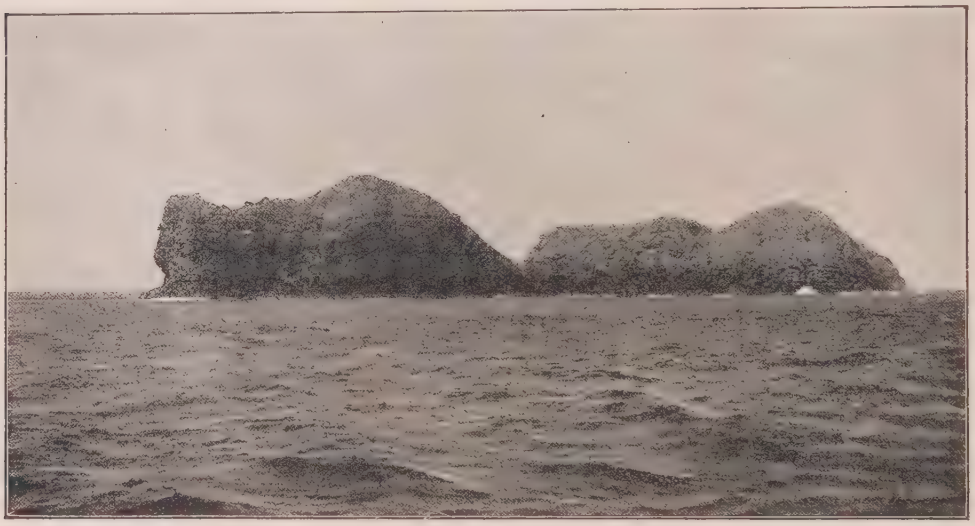
The number of species breeding in the region indicated is not great, there being among the sea fowl only eighteen and of the "land" birds five, including a rail and a duck. On Necker a new tern, of the genus *Procelsterna*, was discovered. This was found to inhabit also French Frigate Shoals and Bird Island.

The following report is in no sense a systematic treatise on the ornithology of the region, but merely a running account of the birds as we saw them during our brief sojourn. Only such technical notes have been included as seemed worthy of permanent record. Systematically, the ornithology of the group has been handled by Mr. Rothschild in his handsomely illustrated "Avifauna of Laysan," based upon material collected in 1891 by Henry Palmer on Laysan, Lisiansky, and Midway islands and the French Frigate Shoals. Mr. William Alanson Bryan's "Key to the Birds of the Hawaiian Group" covers this region also; this book is for the Hawaiian Islands what Ridgway's "Manual" is for North America. Wilson and Evans's "Aves

Hawaiienses" also includes, second hand, the ornithology of the group. Mr. H. W. Henshaw's "Birds of the Hawaiian Islands," which has recently appeared (1902), is the best work we have on the natural history of Hawaiian birds; it also includes references to the Leeward group. In 1896, Dr. H. Schauinsland spent three months on Laysan and many valuable bird notes are included in his "Drei Monate auf einer Koralleninsel," from which I have several times quoted.

The photographs[a] which illustrate this paper were taken by myself, except those of Bird and Necker islands, which are by Mr. Snyder.

In describing the shapes and colors of eggs, as well as the hues of birds, I have used Robert Ridgway's "Nomenclature of colors for naturalists."



Necker Island from the south.

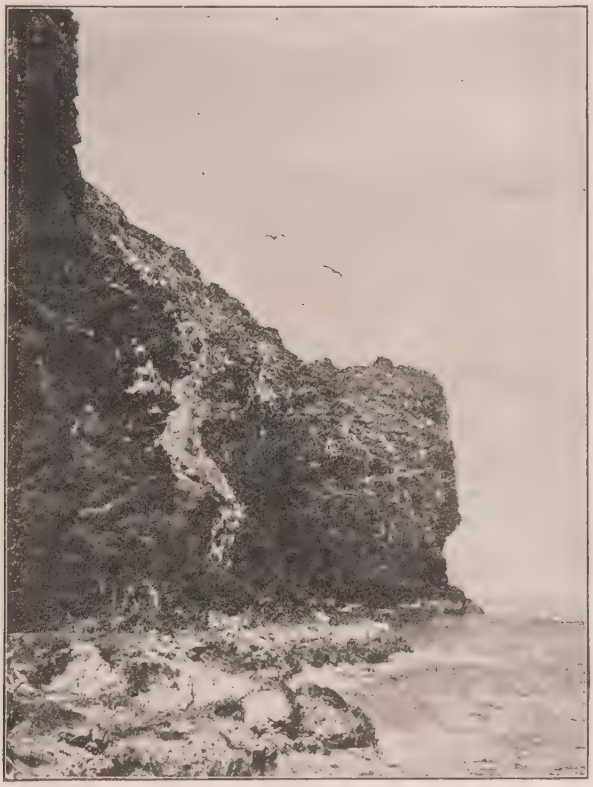
Both on the Laysan trip and during the preparation of this report I have received many kindnesses from several gentlemen. I wish especially to acknowledge my obligations to Mr. Max Schlemmer, of Laysan, formerly of Waimea, Kauai, who, during our sojourn on Laysan, with kindly hospitality entertained Mr. Snyder and myself and rendered numberless favors to all connected with the ship, doing everything in his power to make our visit scientifically a success, as well as a pleasure long to be remembered. Mr. Schlemmer takes the best of care of the birds on the island and has a genuine interest in their welfare. I wish likewise to thank Dr. Charles H. Gilbert, naturalist in charge of the expedition, who placed the entire week at Laysan at my own disposal, and, by kindly encouragement, made this report possible. Acknowledgments are due also to Mr. John O. Snyder, who shared with me the unique experience on Laysan, and who has contributed several photographs to this report; to Mr. William Alanson Bryan, of the Bishop Museum, Honolulu, for the use of specimens and books in the museum; to Mr. Witmer Stone,

[a] For the information of those interested in such things, I might record that Cramer "Crown" 4 by 5 plates were used, Voigtlander collinear lens, Series III, and Graphic box. These make a very convenient and satisfactory outfit. In very few of the pictures was the lens stopped down to any extent.

of Philadelphia, for comparing the type of *Procelsterna saxatilis* with that of *P. cinerea* (Gould) and for looking up measurements and literature; to Mr. Robert Ridgway for the loan of specimens; and to Dr. L. Stejneger and Dr. C. W. Richmond for advice on a question of nomenclature.

NARRATIVE.

The *Albatross* left Honolulu for Laysan Island shortly after noon, May 10. We steamed westward, keeping south of the general trend of the long line of islets and reefs which extend west-northwest beyond Kauai. The following day, when perhaps



North side of Necker Island.

50 miles southwest of Niihau, a flock of mynahs (*Acridotheres tristis*) appeared in the neighborhood of the vessel and flew in narrowing circles around us. Finally several perched on the fore-topgallant yard, and early in the afternoon their number had increased to eleven. Late in the afternoon they left the ship.

It is of interest to find such a land-lover as the mynah so far out at sea, and it shows also that before long the chain of Leeward Islands may become gradually colonized by them. Birds continued scarce till the day before we arrived at Laysan. Occasionally a *Sula cyanops* or an *Anous stolidus* came within our limited prospect, and on the 13th we passed a flock of terns, presumably the sooty, which were excitedly fishing for something. That same evening they flew about in the moon-

light, uttering their sharp, querulous cries, which, once heard, are long remembered. I believe these terns belonged to the large colonies on the French Frigate Shoals, to the northward.

On May 15, when perhaps 75 miles east of Laysan Island, we encountered several species. The black-footed albatross (*Diomedea nigripes*) was fairly common, and I saw a few of the white species (*D. immutabilis*). The sooty and gray-backed terns (*Sterna fuliginosa* and *S. lunata*) were seen all day, and likewise the uau kane (*Puffinus cuneatus*) and red-tailed tropic bird (*Phaëthon rubricauda*). The presence of these birds is of interest in indicating the kinds which habitually go farthest from their nests in search of food.

Bird Island from northwest.

About 5 o'clock on the morning of the 16th Laysan was sighted, and shortly afterwards was clearly visible to the westward, lying long and low on the horizon, with a cloud of sea birds hovering over it. All around us sooty terns were screaming, and gave some hint of the noise which that far-away company was making, but which as yet we could only conjecture. The light-house on the west side rose above the low island, and we were greeted with the Stars and Stripes, which Mr. Schlemmer loyally keeps waving over this tiny spot of land. Long heavy rollers had set in from the northwest, so that, when we arrived off the little settlement on the west side, landing seemed risky. Although one of the party went ashore, a general landing was not accomplished till the following day.

Laysan is a rudely quadrilateral island, perhaps not exceeding 30 feet above sea level in its highest portion toward the north. It is 3 miles long by 1½ broad, and

is formed like a shallow platter. In the center is a lagoon not connected with the sea, which occupies about 100 acres and teems with brine shrimps. The island is considered to be an old atoll which has been elevated. A fringing reef surrounds it, with a passageway on the west side opposite the light-house.

The island has just been compared to a platter; if one stands on the highest part at the north he will see that the land slopes up abruptly from the broad, sandy beach, forming a narrow, grass-covered slope on the north, east and south sides, and a low bluff followed by a level stretch on the west. Thus the highest ridge of the island is relatively very close to the shore. From this ridge or divide the land slopes off gradually to a plain surrounding the lagoon. The narrow littoral slope is clothed with short, wiry grass, trailing morning-glories (*Ipomœa insularis* and *I. pes-capræ*)

South slope of Bird Island.

and other plants that love the spray-laden air. The inner slope is covered with tall, bushy grass that grows in separate tussocks, and several species of shrubs, one of which (*Chenopodium sandwicheum*) covers considerable areas. This grassy portion comprises the greater part of the island, and is succeeded near the lagoon by a narrow zone of juncus. Following the juncus is another belt of a pretty pink-flowered sesuvium, a favorite haunt of the Laysan honey-eater (*Himatione freethi*).

We now arrive at a flat surrounding the lagoon, covered with thin chips of phosphate rock and destitute of vegetable life. This is what might be considered the high-water plain of the lagoon. It is the favorite lurking-place of bands of golden plover (*Charadrius dominicus fulvus*) and wandering flocks of turnstone (*Arenaria interpres*). Some distance from the southwest corner of the lagoon is a little pond of fresh water—or only a trifle brackish—surrounded by a luxuriant growth of juncus, and forming a favorite rendezvous for Laysan teal and bristle-thighed curlews;

and near it are extensive clumps of chenopodium bushes which the little noddies (*Micranous hawaiiensis*) and Laysan finches (*Telespiza cantans*) find particularly favorable for nesting sites. Here also are old piles of broken phosphate rock which teem with birds.

From the top of one of these little hillocks a fine outlook is obtained to the southward over the largest albatross rookery on the island. The ground is bare and nearly flat for a quarter of a mile, and the gony (*Diomedea immutabilis*) has taken almost complete possession. Although the white albatross is distributed fairly evenly over the whole island, with the exception of the beaches, they appear more numerous in this locality. The central portion of the island is very nearly level, and in many places the lime rock has been uncovered for considerable areas. It is here that the best deposits of commercial phosphate rock are found. The ordinary carbonate of lime of the old coral rock, by long exposure to superincumbent deposits of organic matter, mostly in the form of bird excrement, seems to have been largely changed into phosphate of lime. The upper slopes of the island are sandy, and the glare here on a hot summer day is intense. The rock is much deeper beneath the surface of this portion of the island.

At the present writing I have not been able to learn the names of the species of grasses and sedges we brought away.[a] A few of the characteristic plants were not in flower and their definite identification was scarcely possible. A handsome portulaca-like plant, *Sesuvium portulacastrum*, with small reddish-purple flowers, forms extensive beds near the lagoon, as if carefully cultivated. Growing abundantly among these plants is the succulent *Portulaca lutea*, with yellow blossoms. *Heliotropium curassavicum* Linnæus is likewise common near the same place, and *Tribulus cistoides* Linnæus, a creeping plant with handsome yellow flowers, occurs over all the island and is largely visited by the red honey-eaters. *Ipomœa insularis*, a showy morning-glory, is common everywhere, twining up the shrubs and bushy grass. A beach species, *I. pescapræ*, was found near the shore. The large-flowered *Capparis sandwicheana* D'C. had just come into blossom sparingly and was also abundant. *Chenopodium sandwicheum* D'C. likewise is a shrub in great abundance and largely used by nest-building species for their homes. Several other shrubs were without flowers, and I do not know where they belong. Most of the species mentioned above are wide-ranging forms.

Two very striking facts at once impress the visitor—the great numbers of birds and their surprising tameness. The effect of this is at first nearly overpowering. Birds are everywhere, and the noise is sometimes deafening. When we made our way through a populous colony of sooty terns we had to exercise much care to avoid crushing their eggs and treading on the birds, which struggled panic-stricken before us with the old ruse of a broken wing, and then, taking flight, swarmed over our heads. If we would converse, it was necessary to shout.

Turning toward the center of the island we were obliged to cross a wide area covered with tall grass and completely honeycombed with the burrows of petrels (*Æstrelata hypoleuca*). Through the roofs of these tunnels the pedestrian is continually breaking, sinking in the soft soil up to the knee. From out the shadows of the tussocks young albatrosses, uncouth and awkward, snapped their beaks at us,

[a] See appendix for names of plants collected.

and occasionally losing their balance from overhaste, fell forward on their chins. This proceeding usually made them actively sick.

Few of the birds seemed frightened, and with the exercise of a little care we were able to approach most of the species as close as we wished. It was certainly gratifying to be able to walk up to an albatross or a booby and watch it feed its young, and to record this domestic duty with the camera. It might, perhaps, be difficult to convey the pleasure I experienced when, standing in a group of albatrosses, one came up and peered into my face, and finding my intentions good proceeded to examine inquisitively the polished top of my tripod. Many of the young albatrosses would allow themselves to be stroked after a ludicrous show of displeasure, and would soon appear as if they had known us always. The little rails scampered hither and thither, like diminutive barnyard fowls, but soon returned craning their necks to discover why they had retreated. When we sat working, not infrequently the little miller-bird (*Acrocephalus familiaris*) came and perched for a moment on our table and chair backs, and the Laysan finch and rail walked about our feet in busy search for flies and bits of meat. The beautiful little red honey-eater visited us each day at meal time, and sought for "millers" in the crannies and seams between the boards. Thus, wherever we went we were free to watch and learn and were trusted by the birds. It seems a most touching and unique experience, and one which demonstrates all too forcibly the attitude of wild creatures which have not yet learned that man is usually an enemy.

Our visit could scarcely have been better timed. Had we been earlier we would have missed the nesting of the smaller land birds, and, if later, the terns would have all hatched young, and the same is true of the boobies and frigate birds.

The following species were found either with eggs (*) or with young (†):

Sterna fuliginosa.*	Diomedea nigripes.†	Fregata aquila.* †
Sterna lunata.* †	Æstrelata hypoleuca.†	Anas laysanensis.* †
Anous stolidus.*	Puffinus nativitatis.*	Porzanula palmeri.*
Micranous hawaiiensis.* †	Phaëthon rubricauda.* †	Himatione freethi.*
Gygis alba kittlitzi.* †	Sula cyanops.* †	Telespiza cantans.*
Diomedea immutabilis.†	Sula piscator.* †	Acrocephalus familiaris.*

The following, though breeding species, were not laying:

Puffinus cuneatus.	Oceanodroma fuliginosa.

The following migrants were present at the time of our visit:

Charadrius dominicus fulvus.	Heteractitis incanus.
Arenaria interpres.	Numenius tahitiensis.

With such a vast bird population, numbering doubtlessly many hundreds of thousands, it is not surprising that there should be some method in their distribution and that the various species are found more or less in colonies. For reasons best known to themselves many of the species have chosen definite localities. Thus, *Diomedea nigripes* is found breeding on the sand beaches on the north, east, and south sides, but not elsewhere. *Sula cyanops* is restricted to the narrow, littoral, sedge-covered slope on the same sides. *Sterna lunata* chooses the summit of the littoral slope all the way around the island. *Sterna fuliginosa* encircles the islet in a wide band, from the divide along the inner or lagoon slope, inside the ring of *lunata* settlements. *Æstrelata hypoleuca* burrows where the sand is deep throughout the area covered with tall grass, down to near the open plain, where in favorable

places it is replaced by *Puffinus cuneatus*, which thus encircles the lagoon in a ring inside of the immense *Æstrelata* colony.

The distribution of other forms is about as regular as these. Not only is there a horizontal distribution, but also a vertical. The number of breeding birds is so prodigious that favorable space is at a premium, and several species live one above the other. Thus, in burrows beneath the ground are found *Æstrelata* and *Puffinus cuneatus*, and above them *Sterna;* while in bushy areas *Phaëthon* and *Puffinus nativitatis* may take the place of *Sterna.* Still higher, in shrubs, *Telespiza* and *Acrocephalus* make their nests, the topmost branches being occupied by *Sula piscator*, *Fregata aquila*, and *Micranous hawaiiensis.* As Dr. Schauinsland puts it, "the comparison with series of flats in large towns is opportune."

The birds do not all breed in greatest numbers at the same time, but there is a certain succession. This has been well stated by Dr. Schauinsland, whom I quote in translation:

> In spite of this excellent use of all the space at their disposal, the birds which have chosen Laysan for their breeding home would not be able to find satisfactory places if they all arrived at the same time. They are therefore obliged to take turns, so that some species of sea birds leave the place as soon as their young are strong enough to fly, and while the former occupant is leaving the newcomers already begin to arrive. Thus there is a constant coming and going, and it follows that breeding species are found at almost every season of the year, a fact which is remarkable even in the tropics where the breeding season is generally less regular than in our latitudes. In this way a most definite succession, which probably dates back thousands of years, takes place year after year in the arrival and departure of certain species.[a]

During the seven days that the *Albatross* remained near Laysan, Mr. Snyder and myself remained on shore, the guests of Mr. Max Schlemmer, to whom the success of our visit is largely due. We were thus able to verify our few observations on the habits of the birds many times, and Mr. Schlemmer gave us valuable hints as to the location of the land birds' nests. He also presented us with a small collection of eggs. Various members of the party came ashore at different times, and a survey of the island was made by the officers of the ship. Much of our time was necessarily taken with the preparation of specimens, but as often as possible daylight hours were given to photography and observation, while the less interesting but necessary labor of caring for skins was left till after sundown.

On the evening of May 23 the *Albatross* weighed anchor, and on the afternoon of May 28 arrived at French Frigate Shoals. This is an extensive reef under a few fathoms of water, with four sand islands projecting above. The shoal is rudely crescent-shaped, the hollow toward the south, and on its southern edge is a lava rock rising 120 feet above the sea. The larger islands are covered with vegetation, but we were unable to land on account of rough water on the shoal.

Birds were plentiful, especially around the tall rock. Early in the morning terns fairly swarmed over the largest sand islet. We saw here for the first time a graceful little gray tern, *Procelsterna saxatilis*, which was later captured on Necker Island. It was undoubtedly nesting on the tall rock. Other birds which were positively identified were: *Sterna fuliginosa*, *Sterna lunata*, *Gygis alba kittlitzi*, *Anous stolidus*, *Diomedea immutabilis*, *Diomedea nigripes*, *Puffinus nativitatis*, *Sula cyanops*, *Sula piscator*, *Sula sula*, and *Fregata aquila.*

[a] Drei Monate auf einer Koralleninsel, p. 49.

We left the vicinity of the shoal on the evening of May 29, and arrived near Necker Island (latitude 23° 35′ N., longitude 164° 41′ W.) the afternoon of the next day. Necker Island is a dark, forbidding, rather precipitous rock of volcanic origin, attaining a height of 300 feet. It is about seven-tenths of a mile long and is shaped like a rude fishhook, the shaft extend nearly east and west, the barb being a rugged peninsula pointing toward the northeast and inclosing a rocky and turbulent cove.

The island is entirely composed of lava, mostly of a sooty gray or black, with streaks of dull dark-red through it. The sides of the rock, though steep, are intricately terraced, especially on the northeast point, where there is a series of shelves and all sorts of knobs and crannies, making the place ideally fitted for the occupation of birds. The succession of terraces is curious and appears almost artificial in places. Each shelf, from 1 to 10 feet wide, is succeeded by a slightly overhanging rise. These perpendicular steps are full of bowl-like hollows, deep, irregular crevices, and jutting knobs, and form excellent nesting-places for *Gygis alba kittlitzi*, *Procelsterna saxatilis*, *Sterna lunata*, *Puffinus cuneatus*, *Bulweria bulweri*, and *Phaëthon rubricauda*.

Out on the open shelves one finds other birds, such as *Sterna fuliginosa*, *Anous stolidus*, *Sula cyanops*, *Sula sula*, and *Diomedea immutabilis*. The wider shelves of the island are sparsely covered with a fleshy-stemmed, yellow-flowered portulaca (*Portulaca lutea*), and the summit is rather plentifully grown over with *Chenopodium sandwicheum* bushes, on which large colonies of *Sula piscator* and *Fregata aquila* were nesting at the time of our visit. The bright red, puffed-out gular sacs of the male frigate birds could be discerned with a glass from some distance at sea, shining out like great red fruits among the green foliage of the summit.

We landed in a little cove on the north side of the island, through the skillful management of Mr. A. B. Alexander. The rocks rise abruptly out of the water, and the whole north side is very precipitous. A shelf of rock, just above the surf, makes it possible to go about without difficulty. We found birds in great abundance and were fortunate to meet almost at once the diminutive pearly gray tern which we had seen at French Frigate Shoals. This species turned out to be new, and I have called it *Procelsterna saxatilis*[a] because it always lays its egg in hollows among the rocks. Its nearest relative, *Procelsterna cinerea*, is an inhabitant of Australian and New Zealand seas. We were also so fortunate as to discover the eggs and downy chick, and an immature bird in full juvenal plumage.

It proved very interesting to compare the nesting sites of the same species on two such different islands as Necker and Laysan—the one high, steep, and rocky, the other low, flat, and sandy. *Gygis alba kittlitzi*, here much more common than on Laysan, still clung to the rocks. *Sterna fuliginosa* chose the softest spots, where an accumulation of soil had collected on the shelves. Both *Sula piscator* and *Fregata aquila*, as a rule, nested in the bushes on the summit of the island, just as on Laysan. But *Puffinus cuneatus* and *Phaëthon rubricauda* have been obliged to seek crevices in rocks. They seem as prosperous, however, as on Laysan amid the sand. Birds are abundant and most of the available space is occupied. As on Laysan, so here the sooty tern is the most plentiful species, while the black-footed albatross is probably the least abundant of the breeding forms. One interesting find on this island was the eggs of *Bulweria bulweri*, a gentle, retiring little petrel of rather nocturnal proclivities.

Several of the party who climbed to the summit of the rock, not without some

[a] Proc. U. S. Nat. Mus., XXVI, p. 559.

difficulty, found a number of stone shrines. It is believed that the native Hawaiians visited the islands periodically long ago for the purpose of performing religious rites, involving sacrifices.

The following were either collected or positively identified at Necker Island:

Sterna fuliginosa.
Sterna lunata.
Anous stolidus.
Micranous hawaiiensis.
Procelsterna saxatilis.
Gygis alba kittlitzi.
Diomedea immutabilis.
Diomedea nigripes.
Puffinus cuneatus.
Bulweria bulweri.
Phaëthon rubricauda.
Sula cyanops.
Sula piscator.
Sula sula.
Fregata aquila.
Heteractitis incanus.
Arenaria interpres.

We remained on Necker only a few hours, but long enough to gain some idea of the profusion of bird life which characterizes it. Without doubt we were the first naturalists to land, else *Procelsterna saxatilis*, one of the distinctly noteworthy birds, would not have remained so long undiscovered.

Early in the afternoon of the following day, June 1, we sighted Bird Island, rising like a citadel into the hazy sky line, and the *Albatross* came to anchor at dark off the south side. Although we could see nothing of the island, birds were much in evidence by their cries. An *Oceanodroma fuliginosa* flew aboard, attracted by the glare of deck lights, and on the following evening *Bulweria* and *Puffinus cuneatus* were similarly lured in some numbers.

From our anchorage Bird Island appeared like a very steep, half-funnel-shaped hillside, with several bold rocks and cliffs rising from the general slope. Two sulcuses, on the east and west halves, divide the slope into three ridges, and in each little valley there is a group of palm trees. The peak to the west rises 903 feet. The whole of the south side is covered with a growth of bushes and rank grass. This portion of the island suggests half of an old crater. The west, north, and east sides rise as a wall of naked rock, straight and sheer to an imposing height. The west face is black and menacing and perfectly perpendicular.

We were in the vicinity of Bird Island two days, but the sea was too heavy for landing. In fact, a safe landing can be made only in very quiet weather. The shore on the south side is so rocky that even a small swell causes considerable commotion. Birds nest all over the island. Those species which love the cliffs find a congenial home on the precipices and in the escarpments of the south side, while the boobies and man-o'-war birds live among the bushes on the grassy slopes. In fact, the whole mountain seemed alive with *Sula cyanops*, *Sula piscator*, and *Sula sula*. The last species lives along the top of the low escarpment which rises out of the sea along the south side. These three species and man-o'-war birds were continually flying around the vessel, as were likewise the various terns. We noted with pleasure *Procelsterna saxatilis*, which was common. We saw only one or two *Diomedea immutabilis* west of the island some miles, but a number of *nigripes*. Birds collected or otherwise identified are:

Sterna fuliginosa.
Sterna lunata.
Anous stolidus.
Micranous hawaiiensis.
Procelsterna saxatilis.
Gygis alba kittlitzi.
Diomedea immutabilis.
Diomedea nigripes.
Puffinus cuneatus.
Puffinus nativitatis.
Bulweria bulweri.
Oceanodroma fuliginosa.
Phaëthon rubricauda.
Sula cyanops.
Sula piscator.
Sula sula.
Fregata aquila.
Charadrius dominicus fulvus.
Arenaria interpres.

We left Bird Island waters on June 3, and late at night, some 35 miles southwest of the rock, heard many *Sterna fuliginosa*, which were thus scouring the sea at

a considerable distance from their nests, for it is reasonable to suppose that these were nesting birds.

The *Albatross* visited Bird Island again August 5 and remained four days in the vicinity. Although a landing might possibly have been made with considerable risk when we first arrived, the problem of leaving the island proved scarcely reassuring, so that we had to be content with again observing the birds from a distance. All the species seen during the first trip were again noted, with the exception of the albatrosses, both kinds of which were absent. The terns of the year were now full-fledged and flying about, the spotted plumage of the young of *lunata* and *fuliginosa* rendering them especially conspicuous. Young boobies were common also, and all stages of plumage between the immature and adult could be noted. Especially conspicuous were the juvenile *Sula sula*, which are wholly brown. *Procelsterna saxatilis* was still abundant. About 30 miles east of Bird Island we saw a white-tailed tropic bird (*Phaëthon lepturus*). This was the farthest west in the group that we noted the species, although about Kauai, Niihau, Oahu, Molokai, and Maui it was frequently observed.

LIST OF SPECIES.

LARIDÆ.

Sterna fuliginosa. *Sooty Tern.*

Sterna fuliginosa Gmel., Syst. Nat., I, ii, 1788, p. 605.

While the *Albatross* was still some distance from Laysan we could easily distinguish great swarms of birds hovering over the island so as to form a veritable cloud. The greater number of this excited, screaming multitude were sooty terns. Their cries reach one at sea as a low murmur, but in the midst of a populous district the noise is simply deafening, and whenever we wandered among their "nests" we were obliged to suspend conversation.

The sooty terns live in a great colony which extends along the upper half of the interior slope completely around the island, with only a few interruptions, and are thus found almost entirely among the bushy grass; on the west side the community extends nearly to the low bluff overlooking the sea. Their distribution on such a small island is only of interest when compared with that of a near-by related species, the two forms mutually agreeing to keep apart, though necessarily living in close proximity. Thus the white albatross or gony has preempted the greater part of the island and has relegated the black-footed albatross to the sand beaches. So the sooty tern, by virtue of greater numbers, has crowded the gray-backed tern (*Sterna lunata*) toward the sea, where the latter occupies a narrow strip of island between the colonies of *Sterna fuliginosa* and the beaches and also a few scattered localities near the lagoon. It is much less numerous than *S. fuliginosa*, which has evidently gotten the best of the struggle, if struggle there has been. *Sterna lunata* begins to nest sooner than *S. fuliginosa* and presumably arrives earlier.

The sooty terns nest in among the tall grass and the single egg is laid directly on the sand, with sometimes scarcely a hollow to suggest a nest. The eggs are placed very close together in many localities—so close that it is sometimes difficult to progress and not walk on them. The birds are very loath at times to leave their nest, and scold soundly before finally slipping off. When at last driven, they limp away, dragging their wings in a painful manner, just as our own birds do. Thus, here, on a little island, is this firmly implanted instinct strongly in evidence, and practised where it can be of no possible advantage to the bird. Sometimes a dozen or more will struggle on ahead of the pedestrian, trampling over each other and crying incessantly, kicking eggs to the right and left in a mad endeavor to escape, while overhead their fellows keep up an incessant screaming. There is always a great cloud of these birds flying back and forth over the colony, even when no disturbing element is present. They seem to need the nervous excitement. Just at sunrise they are spontaneously most noisy, for then they apparently are returning from the sea, where I have heard them at various times during the night. The illustration of these terns flying gives a good idea of their actions on the wing. (Fig. 2.)

All the eggs of this tern were fresh. We ate many of them while on the island and found them superior to those of the domestic fowl. Mr. Schlemmer informed us that the egg of the albatross is the finest of all.

The eggs of the sooty tern vary much in markings, but can usually be told from those of *Sterna lunata* by greater size and usually coarser spotting. The ground color is white or occasionally a cream buff. One type of marking consists of deep burnt sienna and grayish vinaceous spots, with occasional nearly black scrawls scattered rather evenly over the whole surface. These spots are 1, 2, and 3 mm. in diameter, with occasional larger and smaller ones. Another less prevalent variation consists of heavy, very deep burnt sienna blotches (5 mm. to 15 mm. in extent) congregated in a zone near the blunt end, and lesser pale grayish vinaceous and deep burnt sienna spots sparsely scattered over the rest of the egg. A very handsome type has the brown laid over the vinaceous, and occasionally the deep burnt sienna or chestnut shading off to one side into light, caused by the spiral twisting of the egg in the oviduct.[a] One specimen shows this to a marked degree, having long chestnut daubs extending spirally from the big end.[b] Still another type has fine brown and grayish vinaceous maculations scattered all over the egg, but more numerous at the blunt end. An abnormal specimen s entirely without markings, being pure white. The shape is ovate, either elongate or thick. An average specimen measures 53 mm. by 35 mm.

This species has been found on Midway and Lisiansky islands, and we encountered numbers off the French Frigate Shoals, where in 1891 Henry Palmer found large breeding colonies. On Necker it is the most abundant tern, and as noisy as ever. The birds lay their eggs on the shelves of rocks where there is some soil and matted succulent portulacas. Unlike those on Laysan, all the eggs were advanced in incubation, and many young birds were hatched and peeping. Some were perhaps a week or 10 days old. A few eggs of this species were laid in cavities in the face of the rocks, where the young were eminently able to cling with their sharp little claws. They pecked most savagely if we attempted to dislodge them. Likewise many eggs were laid out on the bare rock in the full glare of the sun, and I saw a few perilously near high-water mark, in fact wet with spray. A number of eggs of *Gygis* were in this position also. Dr. Gilbert found a nest with two eggs, and saw the bird rise from them. The usual number is, of course, only one.

The rocks where we did most of the collecting faced a deep bay, and whenever the gun was discharged thousands of terns would simultaneously shoot out from the face of the crags, as though individually hit, filling the whole cove with an incredibly dense mass of angry birds.

The species was abundant at Bird Island both in June and August. On our second trip we saw many in the spotted juvenal plumage.

Saunders defines their wide distribution as follows: "Tropical and juxta-tropical seas, wherever suitable islands and reefs exist; occasionally wandering to Maine * * * and to Europe, even as far as England. Almost unknown on the South American side of the Pacific, otherwise very generally distributed."[c]

Sterna lunata. *Gray-backed Tern.*

Sterna lunata Peale, U. S. Expl. Exp., Birds, 1848, p. 277.

The gray-backed tern is one of the most characteristic birds of Laysan, and after *Sterna fuliginosa* is the most abundant of the five terns breeding on the island. Its habits are very similar to those of the sooty tern. The colonies of this species, as mentioned under *Sterna fuliginosa*, are somewhat peculiar in distribution. One large, rather scattered community encircles the island like a narrow band, close to the seabeach on the wind-swept sedgy slope facing the ocean and entirely outside the big colony of sooty terns. There are also some separated and small colonies in a similar position with reference to the lagoon. In short, there are two more or less interrupted circles of gray-backed terns, sandwiching between them a much greater community of *Sterna fuliginosa*.

The single egg is laid on the sand, and in some cases on bare phosphate rock. A few young hatched while we were on the island, and all the eggs were advanced in incubation, whereas the eggs of *Sterna fuliginosa* were quite fresh, and many birds had not yet laid. The egg of this species is smaller than that of *Sterna fuliginosa*. No two specimens are alike, as is usually the case, I believe, with sea birds. The ground color is white or very pale yellowish, and the spottings a rich, often

[a] Grinnell, Pacific Coast Avif. No. 1, Birds of the Kotzebue Sound Region, Alaska, p. 24.
[b] Noted also by Snodgrass & Heller, Birds of Clipperton and Cocos Is., <Proc. Wash. Acad. Sci., IV, 1902, p. 507.
[c] Cat. Birds Brit. Mus., XXV, p. 105.

deep, chestnut, over shell markings of lilac gray edged with vinaceous. The maculations are sometimes evenly distributed, fine spots of deep brown over broader splashes of gray, but in the commoner type of marking the spots are larger and more numerous at the blunt end. The contours vary from blunt ovate to elongate ovate. An average specimen measures 46 by 33; an elongate one 48 by 29 mm.

One parent always stands guard over the nestling, and the bird shown in fig. 7, pl. 3, was very solicitous for her young. I found one small company nesting right on the bare sand at the edge of the beach. Often the nest is placed under a bush, which, so far as I am aware, is never the case with the sooty tern.

These terns, when excited, spread their wings slightly, tilt the tail, and walk around in circles, often rising a little on their toes. In flying they do not carry the bill pointed downward like our common tern, for example, but straight ahead like a gull.

Sterna lunata has been recorded from Lisiansky and the French Frigate Shoals. Off the latter islands we found it common, and likewise observed many on Necker. Here the gray-backed terns nested in shallow cavities and hollows of the rocks on the more exposed portions of the island, and only very sparingly on the broad shelves with *Sterna fuliginosa*. At Bird Island we found the species common in June, and again in August, when there were numbers of birds in juvenal[a] plumage.

Saunders gives the distribution of this tern as follows: "Paumotu Islands (Low Archipelago), Society Islands, Fiji group, Phoenix Islands, Hawaiian group, Laysan and Krusenstern islands, Caroline and Pelew islands, Moluccas, Solomon Islands, and probably the intermediate islands of the Pacific." (L. c., p. 101.)

Procelsterna saxatilis. *Necker Island Tern.*

Procelsterna saxatilis, W. K. Fisher, Proc. U. S. Nat. Mus., XXVI, 1903, p. 559.

This handsome little tern we first saw off the French Frigate Shoals, particularly near the large rock mentioned in the narrative, and its identity was much of a mystery. When we landed on Necker Island the same species was soon in evidence, and its egg was found even before we realized to what tern it belonged. The birds are seen usually sitting quietly on the rocks, and their small size immediately singles them from the hosts of other sea fowl all around. They fly with a quick, dove-like wing beat, and were more suspicious of our movements than any of the other species. We never heard them utter a cry. Although they may perch near the "nest," they are extremely non-committal as to its exact position, leaving the neighborhood whenever the egg is disturbed. In fact, only one bird was actually flushed off the egg, and that by Mr. Snyder as he was climbing the steep north face of the island. The single egg is laid in a shallow bowl-like cavity or recess in the rock with no nest, but occasionally a few stray quills and rubbish scattered about. (Frontispiece.)

Although the birds were fairly common, my impression is that the nests were not nearly so numerous in proportion, but I have no doubt that the majority of the birds nested in inaccessible places along the steep face of the rock.

All the eggs were very much incubated and we were able to save but two specimens. These are bluntly ovate and broadly elliptical ovate. The ground color is dull creamy white, in one specimen not very thickly marked with roundish, rod-shaped, Y- and U- shaped and irregular small spots of clay color, light sepia and wood brown, the shell marks showing various tints of bluish gray. In this example the spots are rather evenly distributed over the whole egg. The other egg has more numerous, smaller, and more regular spots, about the size of a dust shot, which are scattered over the whole egg, but are thicker at the blunt end. The gray spots are larger and more numerous than the brown ones. The two specimens measure 36.5 by 26, and 39 by 27 millimeters.

At Bird Island this tern is abundant. We were not able to land on the rock, but from the *Albatross* saw many of them as they flew back and forth. The stomachs of those collected at Necker contained small silvery fishes.

The present species is nearest *Procelsterna cinerea* (Gould), but instead of being ashy gray is more bluish in general tone, with darker upper parts, darker breast, sides, flanks, and lower tail coverts (instead of white of *cinerea*), shorter and slenderer bill, and shorter wings. In some respects it is intermediate between *Procelsterna cerulea* (Bennett) and *P. cinerea* (Gould). This is true of the size

[a] Following Dr. J. Dwight, jr., I have used *juvenal* here and elsewhere to signify the second plumage of a young bird, or that succeeding the natal down. As explained by Dr. Dwight, *juvenile* is inexact. (See The Auk, XIX, p. 251.)

in a general way and also of the color of the under parts. The under parts of *cerulea* are fully as dark as the back, which (in an old skin collected by T. R. Peale, Dog Island, Low Archipelago) is more ashy than that of *saxatilis*.

Procelsterna saxatilis shows its closer kinship with *cinerea* in the light lower parts and light gray wedges on the four outer primaries; but, as mentioned above, it is smaller than *cinerea*, with conspicuously shorter wing and shorter and slenderer bill. The under wing coverts are pearl-gray instead of white, and the breast, sides, and lower tail coverts are decidedly gray, whereas in *cinerea* the lower parts are almost white, and entirely so on the belly. The general tone of the plumage of *cinerea* is ashy, but in *saxatilis* it is somewhat bluish.

While the geographical distribution of the present form is very restricted, so far as known, being found on French Frigate Shoals, Necker, and Bird islands only, that of its nearest relative *cinerea* is rather wide, ranging over "Australian and New Zealand seas, Lord Howe, Norfolk, and neighboring islands, the Kermadec group, also the islet of San Ambrosio, which is nearest to the coast of Chile, but lies outside the cold Antarctic current," and Eua, Friendly Islands. (L. c., p. 136.)

A very interesting point is the fact that *Procelsterna cerulea* (Bennett) ranges in between the two forms, so that in addition to being far removed from its nearest ally, *saxatilis* is further segregated by the intervention of this less closely related species. *Cerulea* is distributed over "central Polynesia, Paumotu or Low Archipelago, the Marquesas, the Society to the Ellice islands, the Phoenix group, and the Fannings (Christmas I.), a little north of the Equator." (L. c., p. 134.)

A redescription of *Procelsterna saxatilis* is here added for the sake of completeness:

Type No. 188651, U. S. N. M., adult male. Bill black; pileum and fore part of cervix, lores, chin, and throat clear light gray (about No. 8 or 9 of Ridgway's nomenclature), shading to darker (between French gray and cinereous) on nape, cheeks and sides of neck, and passing into a trifle lighter gray (No. 7) on sides, hind part of jugulum, breast, flanks, and lower tail coverts. Fore part of jugulum and the abdomen pure white, blending into surrounding gray of sides and breast. Breast almost as pale as the pileum, but becomes gradually darker on sides, sides of neck, shoulders, and malar region, inclosing the conspicuously lighter throat and white jugular patch. An orbital ring is black in anterior two-thirds of upper, in forward and first third of lower parts, and pure white for the remainder. The black and white are conspicuous, being from 1 to 2 millimeters wide. There is a small white area just above black on "eyebrow." The gray of the nape and hind neck and shoulders shades gradually into a darker and less bluish gray over the mantle (about gray No. 5 or slightly darker), which darkens into a decidedly ashy gray (between slate gray and mouse gray) on wing coverts. Secondaries conspicuously edged with white. The feathers of the mantle are vermiculated with almost obsolete bars of lighter gray (present also in *cinerea* and *cerulea*) which show plainly in favorable lights. Primaries dark slate color, an indistinct light gray "wedge" on inner web of first three primaries (reaching to within 25 millimeters of tip on first), less conspicuous on fourth, and represented on remainder by an indistinct lighter edging. Shafts of primaries very dark sepia. Under wing coverts pearl gray, whitish at bend of wing. Rump, upper tail coverts, and rectrices like mantle. Inner web of each rectrix edged with pale gray distally, becoming almost white proximally (less extended than in *cinerea*). Legs in life a dull sepia black, paler toward and on tibiæ and toes; webs creamy flesh color, rather lifeless, with an indefinite edging of sepia next to toes. Iris deep sepia, pupil black. Measurements of type in millimeters: Length, in flesh 285; wing 186; tail 113; culmen 26; depth of bill at nostril (post. end) 5.5; bill from nostril 17.5; tarsus 25; middle toe 32.

Adult female, No. 188652, U. S. N. M. In color like the male, but a trifle smaller (for size see table of measurements).

Juvenal plumage, No. 188653, U. S. N. M., female immature. The upper parts are as a whole darker; the pileum of dark feathers is edged with light gray, giving a mottled appearance. The mantle is darker and more ashy than adult, lacking faint bars, except on longest tertials. Inner tertials, and upper tail coverts edged with light gray. Lower parts, as a whole, lighter than adult, being white except an illy defined band across breast and on throat, which are gray. Sides of head and neck darker than adult. Black portion of orbital ring much wider and more conspicuous than white. White area over eye as in adult. Malar stripe white. Measurements in millimeters: Wing 157; tail 80; culmen 17; tarsus 23.

Nestling, recently hatched (male), No. 188654, U. S. N. M. Completely covered with soft down. Pure white below. Crown white; sides and back of neck very pale buff. Ends of wings white; inner portion of alar and the humeral and spinal tracts brownish gray (down white at tips and brownish gray below). Feet greenish gray; bill blackish.

The following diagnosis will serve to distinguish the three species of this genus:

a. Lower parts nearly as dark as mantle, a decided and rather uniform gray. No discernible white wedges in first three primaries ..... *cerulea*

aa. Lower parts very much lighter than mantle. A more or less conspicuous light-gray wedge in three outermost primaries.

b. General tone ashy. Under wing coverts and lower tail coverts white; breast very pale gray. Size larger: Wing 211; culmen 28 ..... *cinerea*

bb. General tone bluish gray. Under wing coverts and lower tail coverts gray. Breast decidedly gray, whole under parts more suffused with gray than *b*. Size smaller: wing 186; culmen 26 ..... *saxatilis*

I append the table of measurements published with the original description:

Number.	Sex.	Wing.	Tail.	Culmen.	Bill from nostril.	Depth of bill at nostril.	Tarsus.	Middle toe with claw.	Locality.
Procelsterna saxatilis.									
U. S. N. M., 188651. Type	♂ ad.	186	113	26	17.5	5.5	25	32	Necker Id.
Orig. 148	♂ ad.	186	109	25.2	17	5.5	25	32	Do.
Orig. 144	♂ ad.	185−	112	26	17	5.5	25	bent.	Do.
Orig. 147	♂ ad.	186	115	26.5	17	5+	25	32	Do.
Orig. 146	♂ ad.	183	109	25	16	5.5	25	32	Do.
Orig. 145	♂ ad.	185	112	25	16.5	5.5	25	32	Do.
U. S. N. M., 188652	♀ ad.	180	110	25	16+	5	24+	31	Do.
Procelsterna cinerea.									
Acad. Nat. Sci. Phila., 5032. Type		211		28					East coast Australia.
Acad. Nat. Sci. Phila., 5033		*a*206+		28					Do.
U. S. N. M., 15466		*a*195+		27	19.5	6.5	25.5	33	(?)
Procelsterna cerulea.									
Acad. Nat. Sci. Phila., 5029		180		27					Polynesia.
Acad. Nat. Sci. Phila., 5031		178		26					Do.
U. S. N. M., 131532		180		25.5	17+		24	30	Dog Id., Low. Archip

a Wing tip gone.

Anous stolidus. *Noddy.*

Sterna stolida Linn., Syst. Nat., ed. 10, I, 1758, p. 37.

The noddy ranks fourth in relative abundance among the terns dwelling on Laysan. It does not build its nest close among others of its fellows to any marked degree, though I found a few small colonies. The noddies had apparently only recently begun to lay, when we arrived, and I believe their numbers increased during our stay. They were living mostly on the west and northwest sides of the island, where they made their nests on the slopes and summits of the low sand bluffs next to the beach. The nest is usually on the ground, though sometimes it is placed on the prostrate branches of a procumbent shrub. It is a much simpler structure than that of *Micranous hawaiiensis*, and when on the sand usually consists of a shallow bowl, lined roughly with dried sedge. Rarely there is no nest at all, the egg being deposited on the bare ground. When placed on the beaten-down stems of bushes, as is sometimes the case, the nest becomes a makeshift platform of sticks and sedge. The rather acute ovate egg is a creamy white, sparsely spotted with light gray, burnt umber, and walnut brown. Most of the brown spots are on the larger half, and are sometimes small and at other times quite large (4 to 8 millimeters across). One egg has no dark marks, but is scantily spotted and streaked with light Mars brown. Specimens vary from 58 by 48 to 51 by 35 millimeters. (Figs. 12 and 14.)

Noddies like to gather in little companies on the beach, or on rocks near the shore, where they sit for hours dozing away or preening their feathers. They are not so tame as their smaller relative, *Micranous hawaiiensis*.

We found this species off the French Frigate Shoals, from which it has already been recorded by Rothschild. Likewise on Necker it was fairly common, and we found nests and eggs. Here the nest was smaller than on Laysan, the material being restricted from necessity to the fleshy stems of *Portulaca lutea*, which grows abundantly on the shelves of the rocks. As on Laysan, the birds gathered on the rocks near the water's edge just out of reach of the surf. We found the species at Bird Island, both at sea and on shore, where they were seen standing on the beach.

This tern has a wide range, which is given by Saunders as follows:

"Tropical and juxta-tropical America; chiefly on the Atlantic side, but also on the Pacific in

Mexico and the central region; Atlantic down to Tristan da Cunha (breeding); intertropical African and Asian seas up to Yeddo; islands of the Pacific up to Laysan, etc., and as far as Sala y Gomez, 105° W.; also Chatham I., Galapagos (fide Ridgway), but not on coasts of Peru or Chile. Breeding, as a rule, where found. Once obtained off the south coast of Ireland." (L. c., p. 140.)

Micranous hawaiiensis. *Hawaiian tern; Noio.*

Micranous hawaiiensis Rothschild, Bull. Brit. Orn. Club, No. x, July, 1893, p. xvii.

This handsome little tern is one of the most characteristic birds of Laysan, where it nests in considerable numbers, ranking perhaps third in relative abundance among the terns. Saving the noddy, it is the only one which builds any nest worthy of the name, and hence is remarkable for this reason alone. The birds live in small communities, scattered over the island, either near the sea or in the interior. I found nests in two different kinds of bushes, and they were placed anywhere from 18 inches to 3 feet up, according to the desirability of location. They are constructed of twigs, usually morning-glory stems and leaves, and are from 10 to 12 inches in diameter. Usually the nests are built flat on top of the bushes, or sometimes below in a crotch. There is scarcely any hollow, and occasionally a few feathers enter into the lining of dried leaves. The nests are in a large number of cases completely plastered over with droppings, and are used year after year. (Figs. 9, 10, 11.)

The single egg is laid early in May, although from perfectly fledged birds, which were common, I should judge these eggs to belong to the second setting of the year. All were more or less advanced in incubation. They present some variation in size and hue. The ground color is either nearly pure white, creamy white, cream buff, pale buff, or even light vinaceous buff. Sometimes the egg is heavily blotched and streaked with chestnut at the large end, with only pale, partially obscured, markings elsewhere. Again, these blotches and smaller spots are scattered over the egg. In another type the deep burnt umber maculations are in small spots and irregular lines from 3 to 8 millimeters long, with many nearly obscured larger spots all over the egg. No two eggs are alike in color, and it is impossible to define any special type, unless it be the pale-buff ground tint, with scattered deep-brown blotches and streaks. The pale-brownish ground color is quite characteristic, though some eggs are almost pure white. The prevalent shape is ovate, sometimes very blunt. A large egg measures 47 by 33, a smaller specimen 43 by 30 millimeters.

This little tern is quite unsuspicious and allowed us to approach closely. When disturbed from its egg the noio flies about in circles as if in doubt, and finally settles on the edge of its nest, as shown in fig. 10. Numbers of them habitually sit in company on the tops of bushes facing the wind, some flying off occasionally and others joining the group. Their only occupation during these assemblies seems to be preening their feathers. Very few were seen at sea during the day, so that they must fish considerably after nightfall.

Speaking of this tern about Hawaii, Mr. H. W. Henshaw writes: [a]

"The noio lives wholly upon fish, to obtain which it habitually makes excursions offshore 10 or 15 miles. Indeed, comparatively little of its food is obtained inshore, though occasionally they may be seen slowly winnowing their way along the surf-streaked coast and scanning the heaving billows with anxious eye for their quarry.

"While following its prey on the broad ocean the noio is of much service to the Hawaiian fishermen, and acts as his pilot; for its presence in numbers in a given spot marks the whereabouts of shoals of noi, a long silvery minnow, and there also is sure to be found the aku, or skipjack, much sought after by the fishermen. This tern never dives for fish, but with a quick stoop and a dip of the head it seizes the unsuspecting minnow when close to the surface.

"In the olden time I learn that the natives used to raid the nesting sites of the noio pretty regularly for both eggs and young, the latter especially being esteemed delicacies, as indeed were the young of most sea birds. For this purpose dark nights were usually chosen, and by means of torches and the help of clubs the old birds, bewildered by the light, were easily secured."

Henry Palmer found this tern on Lisiansky and Midway. [b] We did not see any at French Frigate Shoals, but observed a number on Necker, without discovering any nests. We also saw them at Bird Island in August. The species is not uncommon in the Hawaiian group proper, and is recorded from Hawaii, Molokai, Oahu, Niihau, and Kauai. As a wanderer it is found likewise on the other islands. So far as our knowledge goes at present it does not breed outside this region.

[a] Birds of the Hawaiian Islands, etc., 1902, p. 125. [b] Rothschild, Avifauna of Laysan, etc., p. 43.

Gygis alba kittlitzi. *White Tern.*

Gygis alba kittlitzi Hartert, Katal. Vogelsamm. Senckenb. 1891, p. 237.

On Laysan the white tern, or love bird, as it is sometimes called, is one of the least abundant of the breeding sea birds. Small colonies are scattered over the interior of the island, but the largest is found in the vicinity of the fresh-water pond. Here the little white terns lay their eggs on lumps of phosphate rock, among bush grass, or under the overhanging shelter of some shrub or clump of vines. Only one egg is deposited. We found all gradations, from fresh eggs to fully fledged young, which resemble the parent. The nestlings clung to the rocks with great persistence and fortitude. The air of independence which they are capable of assuming is very amusing. A peculiar trait of this white tern is its habit of occasionally depositing its egg on the bare limb of a bush, as depicted in plate 4, fig. 16. Here the bird stands over it, with confidence born of success probably, and the young is undoubtedly hatched, though we saw none. We watched the bird sitting on the egg shown in the photograph, and when she flew off it was not disturbed in any way. It is safe to assume that a heavy wind would play havoc if this habit was very general. We frequently saw these terns resting near their "homes," the two standing side by side, but they do not seem to brood so much as other species. They do not sit on their egg in the ordinary manner, but stand over it, as their legs are short.

The eggs are very handsome, the ground color varying from a faint greenish through very pale buff, cream, and white, with traces of yellowish. The marking is different on each egg. One is heavily blotched with French gray, over which are thick irregular lines and streaks of raw umber forming a band near the larger end, but scattered over the whole egg. Over this are fewer lines, almost black, confined to larger half. Another egg is streaked and mottled with drab-gray and olive. Other eggs are heavily blotched with slate gray, over which are irregular patches of very deep Prout's brown, almost black in spots. In some examples the markings tend to become streaks; in others irregular spots. The shape is bluntly ovate, broadly elliptical ovate, or oval, which last is perhaps the most prevalent contour. An ovate specimen measures 42 by 30, an oval 40 by 32 millimeters.

The old bird brings two silvery fishes to the young and she invariably carries them crosswise in her bill. Dr. Gilbert captured two such fishes from a young tern. These turned out to be a silvery half-beak, and some species not yet identified. Mr. Schlemmer told me he had always observed two fishes, but Henry Palmer,[a] on Midway Island, saw an old bird with "not less than four in its beak at once." The interesting part is how the old birds capture the additional fish and still retain the first one. Certainly the difficulty would seem great in the case of four fishes!

Whenever we happened to wander near their eggs or young the white terns came and hovered in front of our faces and peered intently at us as if trying to divine our intentions. Just out of reach they would flutter, turning their heads from side to side, occasionally uttering a droll and wheezy little cry. They did not offer to peck us, but were content to stare and wheeze. When fully satisfied they flew silently away, looking back from time to time, but would sometimes return for several additional inspections. Not infrequently, when we were nowhere near a colony, one of these terns, attracted by the unusual sight of white helmets, changed its course and came close to gaze at us with the same disconcerting intentness.

Some idea of the beauty of this species will be gained when it is remembered that their plumage is pure white, except a black orbital ring.

Henry Palmer (op. cit., p. xvi) found *Gygis* abundant on Midway Island and observed it at Gardner Rock, and we saw many individuals off French Frigate Shoals. On Necker it is one of the commonest terns, far more abundant than on Laysan, and I am inclined to think that the species finds the rocks a more congenial home. The seeming disregard for the welfare of the egg is well demonstrated here, for it is deposited on any little insufficient shelf of the rock, usually at the edge of some shallow cavity, where it clings, so to speak. I confess myself somewhat astonished at the recklessness of this little tern. How the egg is ever balanced on some of the extraordinary places upon which it is deposited, when the birds are continually flying on and off, passes comprehension. I observed many nestlings, all small, and saw one little bird emerging from the egg, its mother standing over it and resolutely refusing to desert her offspring, even though I stroked her back. She did not appear frightened, but rather indignant at intrusion. The species nests all along the steep face of the island, where they can be easily seen against the dark rock. Also at Bird Island we found the species

[a] Rothschild, Avifauna of Laysan, etc., p. xiv.

common, both in June and August. Here against the blackish crags the little white specks shone out plainly, as on Necker.

Saunders in the British Museum Catalog does not separate *kittlitzi* from *alba*. The combined distribution of the two forms is given by this author as follows:

"Fernando Noronha, Trinidad and Martin Vas Islets, Ascension, St. Helena, Madagascar, Mascarene Islands and vicinity, Chagos group, Bay of Bengal, Malaysia to Australia, Polynesia to Ducie Island, and the Central Pacific generally, up to the Sandwich Islands and Krusenstern Islets."

Gygis alba kittlitzi was described by Hartert from the Caroline Islands, and has been determined by Rothschild and others to be the form from the Hawaiian group. It is probable that all the birds from localities north of the equator belong to this form. Although described as a subspecies, the form will probably be found to be a full species, as the presence of intergrading forms seems a little improbable.

DIOMEDEIDÆ.

Diomedea immutabilis. *Laysan Albatross; Gony.*

Diomedea immutabilis Rothschild, Bull. Brit. Orn. Club, No. IX, 1893, p. XLVIII.

With many ornithologists the word Laysan is so intimately connected with pictures of albatrosses that the two have become inseparably associated. Surely no birds can stand out more vividly in our memory than these splendid creatures, not alone on account of their great numbers and remarkable appearance, but more perhaps from the unusual charm and interest which attaches to their personalities. Their large size and striking plumage at once raise them to an exalted place among all sea birds, a position similar to that which tradition and fancy have accorded the eagle among birds of the land.

The Laysan albatross or gony is distributed all over the island, with the single exception of the beaches, which on all sides except the west are colonized by the black-footed albatross. The flat plain surrounding the lagoon is their favorite habitat, and we found the young here in far the greatest numbers. This great colony extended all the way around the lagoon, but certain portions were more congested than others. The largest single colony of young is on the south side of the lagoon, where the ground has been leveled off in past years by phosphate-rock diggers. Here from a little eminence one can look off and see many thousands of birds at a glance, but it would be hazardous to guess how many there are on the whole island. At the time of our visit the young were about two-thirds grown, the white feathers of the breast and abdomen having in most cases the appearance of the adult, but the rest of the body was covered with long brown down, except on the head, where it was short. The beaks of the young are dark dirty gray or brownish gray, while those of the adult are light greenish. There seems scarcely a tussock of the grass which covers the greater portion of the slopes of the island but has an ungainly young bird in its shadow ready to snap at the intruder with a show of ferocity. These amusing creatures sit on their heels with the whole length of the tarsus on the ground or tilted slightly in the air, as shown in the illustration. Their spare time is spent in gazing stupidly around, but if their reverie is at all disturbed by one passing too near they fly into an apparent rage, lean forward and snap their beaks viciously, or sway their uncouth bodies from side to side in a frantic attempt to maintain a balance. Sometimes they make a rush, waddling along and darting their heads back and forth to the music of clicking mandibles. But they only occasionally come to the point of biting, and are always amenable to tact and persuasion. (Figs. 18–21.)

Usually, after the first paroxysm of snapping is over, one can stroke them with little danger of scratched hands. They maintain a small fire of objection, with impotent nips, or try to sidle off. But sometimes a youngster is more determined than the rest. It often happens that in an eager rush to scare an intruder the young bird stumbles in a petrel's hole and falls forward with considerable force on its chin. In some way nature never meant an albatross's head to be lower than its stomach, or the concussion affects it unpleasantly, for usually it disgorges its breakfast very promptly and energetically, but curiously I never saw them do this without first falling over. After such a performance the young one looks dejected, for it is usually left hungry, and hunger is its chief trouble.

The old birds, however, are quite different, and do not seem to mind the presence of man. One can walk among them without disturbing their various occupations and amusements in the least. Only when suddenly startled do they exhibit any tendency to snap their bills, and then they are easily calmed. They back away from any proffered familiarity with great rapidity, unless suddenly hindered by a tuft of grass, which event surprises them immoderately. They will not allow themselves to be

handled, and make off at a great rate if one offers them this indignity. They have a half-doubting inquisitiveness which leads them sometimes to walk up to the visitor and examine anything conspicuous about his person. One bird became greatly interested in the bright aluminum cap to my tripod, and strolled up and examined it carefully with both eye and beak, appearing somewhat astonished when the cap tinkled.

Matters always seem to go harmoniously among the members of a colony and no ill-will was shown between adults. The young birds, however, occasionally had slight misunderstandings, and between the old birds and strange young ones there existed at times of feeding a peculiar animosity.

When standing beside their young they present a very attractive sight, as their plumage is always immaculately clean. The region about the eye is dark-grayish, overhung by a pure white eyebrow, which gives them a decidedly pensive appearance. They have an innate objection to idleness, and consequently seldom stand around doing nothing, but spend much time in a curious performance, the meaning of which I am at a loss to explain. It has been called courting (Avifauna of Laysan, etc., p. 57), but as the antics are carried on during the birds' residence of about ten months on the island, they are probably an amusement, in which the albatrosses indulge immoderately in lieu of other diversion. This game, or whatever one may wish to call it, may have originated in past time during the courting period, but it certainly has long since lost any such significance.

The proceeding in brief is as follows: Two albatrosses approach each other bowing profoundly and stepping rather heavily. They circle around each other nodding solemnly all the time. Next they fence a little, crossing bills and whetting them together, pecking meanwhile, and dropping stiff little bows. Suddenly one lifts its closed wing and nibbles at the feathers underneath, or, rarely, if in a hurry, merely turns its head and tucks its bill under its wing. The other bird during this short performance assumes a statuesque pose and either looks mechanically from side to side or snaps its bill loudly a few times. Then the first bird bows once and, pointing its head and beak straight upward, rises on its toes, puffs out its breast, and utters a prolonged nasal groan, the other bird snapping its bill loudly and rapidly at the same time.

Sometimes both birds raise their heads in air and either one or both utter the indescribable and ridiculous bovine groan. When they have finished, they begin bowing at each other again, almost always rapidly and alternately, and presently repeat the performance, the birds reversing their rôle in the game, or not. There is no hard and fast order to these antics, which the seamen of the *Albatross* rather aptly called a "cake walk," but many variations occur. The majority of cases, however, follow the sequence I have indicated. Sometimes three engage in the play, one dividing its attention between two. They are always most polite, never losing their temper or offering any violence. The whole affair partakes of the nature of a snappy drill, and is more or less mechanical. (Figs. 25–28.)

Occasionally one will lightly pick up a twig or grass straw and present it to the other. This one does not accept the gift, however, but thereupon returns the compliment, when straws are promptly dropped and all hands begin bowing and walking about as if their very lives depended upon it. If one stands where albatrosses are reasonably abundant, he can see as many as twenty couples hard at work bowing and groaning on all sides, and paying not the slightest attention to his presence. When walking through the grassy portions of the island, I have seen white heads bobbing up and down above the green, as solitary pairs were amusing themselves away from the larger congregations of their kind. If I walked up to them, they would stop and gaze in a deprecating way, and walk off, bowing still, with one eye in my direction. Having reached what they considered a respectful distance, they would fall to and resume their play.

Should one enter a group of albatrosses which have been recently engaged in this diversion and begin to bow very low, the birds will sometimes walk around in a puzzled sort of way, bowing in return, a curious fact, which F. H. von Kittlitz recorded as early as 1834:

"When Herr Isenbeck met one, he used to bow to it, and the albatrosses were polite enough to answer, bowing and cackling. This could easily be regarded as a fairy tale; but considering that these birds, which did not even fly away when approached, had no reason to change their customs, it seems quite natural."[a]

One moonlight night we strolled over the island after nocturnal petrels and visited a portion of a populous albatross colony. The old birds were still hard at work executing that queer "song dance," and in the uncertain light the effect was one long to be remembered. Their white plumage made them conspicuous for a long distance over the stretches near the lagoon. From all sides the sound of

[a] Extract from Avifauna of Laysan, p. 111 (F. H. von Kittlitz in Museum Senckenbergianum, I, pp. 117 *et seq.*).

their groans and bill-snappings was audible above the continual thin, high squeak of young albatrosses and the moans and caterwauling of shearwaters and petrels. During some quieter spell in the activities of the vocalists far-away groans were borne to us across the placid lagoon, as a reminder that in other parts the good work was still going on. By this time many of the albatrosses had started off fishing, as they seem to do a large part of it after dark, probably toward morning.

It is interesting to note that the antics which have just been described are not limited to this species, but, in a modified form, are practiced by *Diomedea nigripes*, and are mentioned also by Rothschild and Hartert[a] in connection with *Diomedea irrorata* Salvin. Probably all species of the genus exhibit the trait in some form.

After sunrise the albatrosses begin to feed the young. The old bird, coming in from the sea, alights near her offspring, which immediately takes the initiative by waddling up and pecking or biting gently at her beak. This petitioning always takes place and perhaps acts as some sort of stimulus, for in a few moments the mother stands up, and with head lowered and wings held loosely at the side disgorges a mass of squids and oil. Just as she opens her beak the young inserts its own crosswise and skillfully catches every morsel, which it bolts with evident relish. This operation I saw repeated, with short intermissions, ten times. The last two or three ejections of this oily pabulum cost the albatross considerable muscular effort, and the last time nothing came up but a little oil, and stomach juices presumably. The young bird is not at all modest in its demands, but keeps asking for more. The old bird now pecks back in an annoyed manner, and if the other still urges, she arises and walks off, usually to some neighboring young one, which she viciously mauls about the neck. This exhibition usually takes place just before she feeds her young and likewise between courses, as it were. Why she does this I am at a loss to suggest, unless it be mere ill-will. The old bird does not always confine this ill treatment to one strange young bird, but takes in a circle of those whose parents are absent. The young thus rudely treated sometimes bite back, but usually do not offer resistance, uttering instead a plaintive little squeak. A small mortality is the result of this practice. Dr. Gilbert observed that *Diomedea nigripes* is more savage than the white species. He saw a black-footed albatross thus take in a circle of about twenty young *immutabilis* and "wool" them soundly. Finally, however, the ruffian arrived at a youngster whose parent, being unexpectedly near by, set upon the persecutor, and in the scrimmage *nigripes* was put to rout. (Figs. 22–24.)

Near the forms or nests one not infrequently finds solid pellets—disgorged by the young in all probability, and by old birds too—consisting entirely of squid beaks and opaque lenses of the eyes. These lenses become very brittle and amber like under the action of stomach juices and show a concentric structure. Candle nuts, the large seed of *Aleurites molluccana*, were found by Mr. Snyder in the interior of the island and were almost undoubtedly ejected by albatrosses. As is well known, albatrosses pick up all sorts of floating material, and candle nuts are frequently seen on the ocean, having been swept seaward by mountain streams. The nearest trees are on Kauai, about 700 miles east. This suggests a means by which many hard, floating seeds might be carried into the interior of islands by albatrosses, shearwaters, petrels, and frigate birds, and thus obtain a foothold, whereas if swept ashore on barren rocks or beaches they would stand little chance of ever germinating.

The white albatross or gony lays one egg, on the ground or frequently in a slightly raised mound with a shallow basin in the top. We saw numbers of these "forms," almost worn out by the young birds. According to Mr. Schlemmer, the egg is laid about the middle of November. We were of course out of season to secure any, although we saw numerous spoiled ones half buried in the sand. Rothschild[b] describes them as follows:

"I have received a series of eight eggs of *D. immutabilis*, which vary very much both in shape and coloration. The two extremes are as follows:

"1. Very elongate; length 111.5 mm.; width 62.5 mm.; ground color dirty white, marked with numerous large and small blotches of a brownish-maroon color, which are principally massed at the two ends, though there are a few in the central zone.

"2. Very thick and short; length 100 mm.; width 70; color, uniform brownish buff without any markings whatever.

"The majority of specimens before me are dirty white with irregular patches and spots of brownish-maroon at the larger end."

[a] Novitates Zoologicæ, VI, 1899, p. 125.

[b] Avifauna of Laysan, etc., p. 291.

In the "Avifauna of Laysan" there is a plate showing "carloads" of albatross eggs, supposed by many persons to be ready for shipment to Honolulu. Mr. Schlemmer assured me that eggs have never been sent to Honolulu from Laysan, and that these eggs were gathered together by a photographer, who could find nothing better to do, for the purpose of a spectacular picture. The photograph has had a rather wide circulation and led to some criticism of Mr. Schlemmer's predecessor.

The albatrosses begin to arrive on Laysan about October 25 and 26, and they remain till the following August. Dr. Schauinsland says:

"During the last days of October the first vanguard of the mighty albatrosses appeared, and a few days afterwards the island looked, from an elevated point, as if it was densely covered with large snowflakes. There was hardly a spot of ground on which the dazzling white plumage of an albatross was not apparent and the number of these birds is often so large that many are obliged to be content with rather unsuitable spots, and many must leave the overcrowded area." [a]

The young are hatched in February, according to Mr. Schlemmer. They then are covered with a grayish-white down [b] which is soon superseded by a plumage of dark-brown down, assumed by a continued growth of the original covering and a wearing off of the gray tips. As the young birds grow older the white feathers come in on the breast and abdomen first, and the brown down is in direct communication with the terminal barbs of these juvenal feathers, as is, of course, well known. The feathers of the back also come in about the same time, and those of the wings, save the quills.

In large colonies of animals, it has always been something of a problem how a parent is able to find its young among so many of its kind. The voice is probably responsible in some cases, but as birds are extremely keen of sight and evince a positive genius for discriminating landmarks, I believe the albatrosses must in some way depend upon peculiarities in the surroundings of their young. It is worthy of record, however, that the young often "sing" in a thin, high squeak, which is kept up continuously for periods, and may be of service in guiding the parent, though I could not distinguish the slightest individuality in tone. I do not know whether they do this when the old birds are present, but remember that very many were engaged in the cricket-like song when we visited a populous colony late one moonlight night.

I saw numbers of the young sleeping, their eyes being tightly closed and bills tucked under their wings. Some of them did not awake till touched, and then naturally were much startled. The old birds seem to be wide-awake at night, but about 9 or 10 o'clock in the morning they frequently sleep near their young, with the bill and one eye covered by the wing.

The shallow, basin-shaped hollow in which the egg is deposited, is the young albatross's home and it usually does not stray far. But as the nestlings grow stronger so that they can walk a little, albeit very awkwardly, they wander sometimes a rod from the home spot and engage in mild squabbles with youthful neighbors. The same feeling of growing strength leads them about this time to slowly fan their wings back and forth from time to time. During a light shower I saw a considerable colony of young birds do this together, after the manner of cormorants drying their wings. When the breeze is rather brisk they usually all face it. Their spare time is taken up with idly dozing in the hot sun, preening their feathers or examining their surroundings. Several times I observed young birds collect dried grass and similar material, which happened to be within reach, and carefully cover the hollow in which they were sitting. Sometimes their spirit of inquiry leads them into trouble. We found a young bird, still lively, buried to its neck in a collapsed petrel burrow. It objected strenuously to being disinterred, but appeared little the worse for its adventure.

We saw a few *Diomedea immutabilis* on one of the smaller islands of the French Frigate Shoals, but the species is evidently not plentiful there. On Necker it is rather abundant, over the top of the island, where there is more or less vegetation. Dr. Gilbert estimated roughly that there might be from one to two thousand birds. They are also scattered over the shelves on the sides of the north point, where I saw an old one feeding her young. She was much more timid than any birds we encountered on Laysan. During our first visit to Bird Island, June 2, I saw one or two of this species, but on the second trip, in August, none were noted.

The gony was not seen about the Hawaiian group proper, where it occurs only as a migrant. The species is known to breed on Midway, [c] Lisiansky [c], Laysan, French Frigate Shoals, Necker, and

[a] Drei Monate auf einer Koralleninsel, p. 52.
[b] Rothschild, Avifauna of Laysan, p. 29.
[c] Avifauna of Laysan, etc., pp. 57, and XIII.

Bird islands. When not caring for its young it is a wanderer, and the following paragraph from Rothschild's Avifauna of Laysan gives some idea of its extralimital distribution:

"*D. immutabilis* is, as a migrant, widely spread. Mr. Alan Ownston sent me a specimen killed on Myiakejima, Japan, in October, 1893 (Bull. B. O. Club, III, p. XLVII, June, 1894). In the Muséum d'Histoire Naturelle, in Paris, I have seen a specimen killed near Hawaii by M. Bailleu. Mr. A. W. Anthony found this species near San Gerónimo and Guadalupe islands on the coast of Lower California, and it is to be suspected that several reports of albatrosses observed on the western coast of North America refer to this species, and perhaps also some of the specimens mentioned by Cassin (U. S. Expl. Exp., p. 399) might have been *D. immutabilis*. Certainly the birds mentioned by Pickering (l. c., p. 401) as being observed between Oahu and the northwest coast of America, and as being '*all* of a blackish or dark dove-color with a white frontlet or a circle around the base of the bill,' were all *D. nigripes* and not the young of the white species; but the white birds described on page 399 could only have been *D. immutabilis* or *D. albatrus*" (p. 292).

About 1,000 miles northeast of Oahu, on the Great Circle route to San Francisco, we saw a white albatross, which I feel reasonably sure was this species (August 25).

Diomedea nigripes. *Black-footed Albatross.*

Diomedea nigripes Audubon, Orn. Biog., v, 1869, p. 327.

The black-footed albatross is very much less abundant on Laysan than the white species. It colonizes the sandy beaches on the north, east, and south sides, but is not found, except rarely, on the west side. It is likewise common on the sedge-covered slope near the beach, in the same habitat with *Sula cyanops*. On one or two occasions I noted them in the interior with *D. immutabilis*.

The habits of this bird are very similar to those of *Diomedea immutabilis*. They feed their young in the same manner, abuse the nestlings of neighbors, and engage in the peculiar performance described above. Although very docile in expression, their treatment of the young of neighbor birds is not carried on in a mild or playful mood. Their beaks are very powerful, and when they unmercifully "wool" the young ones, the process sometimes finishes the victim, for young which appear to have been misused are frequently seen lying around dead.

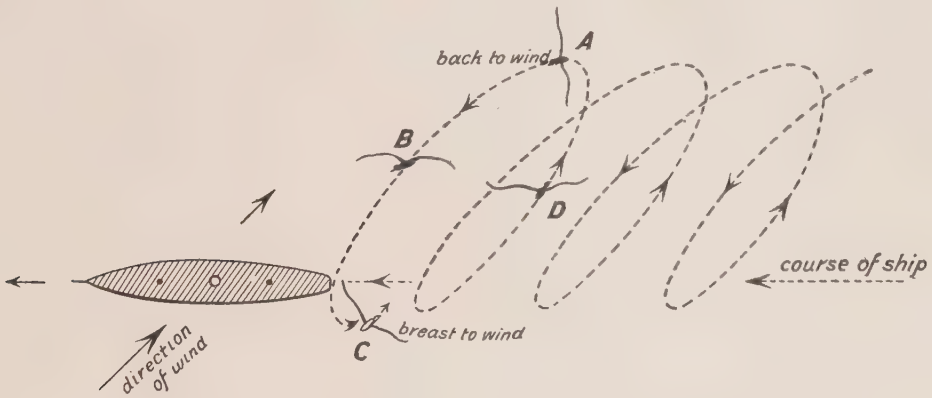
We saw this species rather seldom engaged in the curious dance, and indeed they impress one as more matter-of-fact creatures. The only difference which was noted in the ceremony as carried out by the two species is that *nigripes* spreads its wings slightly (the metacarpus or "hand" being folded closed) when it lifts its head to utter its nasal song.

This species was found on Midway and Lisiansky by Henry Palmer. We saw it also at the French Frigate Shoals, and sparingly on Necker and at Bird Island. None were observed at Bird Island on our second trip in August. It is seen at sea much more than *D. immutabilis*, and it followed our ship almost continually on the return trip from Laysan. As wanderers these birds were seen in very limited numbers in Hawaiian waters, that is, about the Windward Islands. All the birds which follow steamers from California leave when within about 500 miles of Oahu, and on our return trip to California they joined us about 1,200 miles from San Francisco, and 1,000 from Oahu. All through the night one can see them following at a distance, or close at hand, sometimes settling on the water for rest or food.

As is well known, albatrosses are past masters at soaring or sailing. If the wind is favorable they are able to skim over the water for a long time without once flapping their wings. *Diomedea nigripes* is certainly no exception to the general rule, and we had ample opportunity to witness their powers. The long, slender wings, with long humeral bones, are eminently fitted for this sort of existence, and their construction renders flapping laborious, for in proportion to its size the albatross is not a very muscular creature and could not fly a great distance if obliged to do so by wing beats. When a stiff breeze is blowing albatrosses can sail only against the wind or with it, and are able to quarter a breeze, or go directly across it only for a short distance and when under great momentum. When we were steaming directly against the wind the albatrosses had no trouble in following us, and they would fly all around the ship without flapping their wings except when the breeze was strong, and then they were obliged to give a few vigorous beats when turning up into the wind. When, however, our course lay at an angle to the wind, as shown in the accompanying diagram, they followed us by sailing in a series of ellipses. They would, in this case, sail directly against the wind, approaching us on the starboard quarter, go over the stern a short distance to port, then wheel and scud before the breeze perhaps 100 yards off the starboard quarter, when they turned and approached us as before. Their speed was so superior to ours that they were able to keep up without any trouble, and their

frequent trips astern and rapid overhauling again made our cumbersome gait all the more apparent. Of course as they neared the turning point each time they had to quarter the breeze a little and for a moment sail directly across it. Sometimes at A in the diagram they were obliged to flap rather frantically to keep their equilibrium.

The position in which the wings are held when sailing against or with the wind is quite characteristic in either case. When coming against the breeze the carpal segment and primaries are bent downward, as if to catch the wind, so that the bird appears as in B; but when the bird turns and goes with the breeze the ends of the wings are bent up, as in D. When sailing against the wind they often gradually rise, but they are likewise perfectly capable of descending, and when going swiftly with the wind they not infrequently, in fact usually, make a long swoop downwards and skim over the water, rising a little as they turn to come to windward. The position of the wings in the two cases seems to be constant. In the first case they catch more wind, and the fact that the birds generally rise a little shows that the wings act on the same principle as a kite. On the other hand, when sailing with the breeze, the position is such as gives less resistance to the wind. The first position (B) is, as suggested by Dr. Gilbert, one of great muscular rigidity.



One is impressed, when watching these birds, with the fact that there is a tremendous amount of muscular tension brought into play to preserve an equilibrium. We are told that wind is not a constant movement, but is made up of a series of lulls and gusts following each other. With consummate skill, the soaring bird seems forever balancing itself and taking advantage of these little blasts. When there is very little breeze albatrosses are not able to sail far, and during a dead calm they progress by a series of flaps and short sails.

The albatrosses frequently settle on the water, and their actions when so doing are very ludicrous. As they are about to alight both feet are sprawled out on either side, and they strike the water with a splash. The wings are held high over their heads till the birds are safely settled, when they are folded with extreme care, so as not to become the least wet.

PROCELLARIIDÆ.

Puffinus cuneatus. *Uau Kane; Wedge-tailed Shearwater.*

Puffinus cuneatus Salvin, Ibis 1888, p. 353.

The uau kane is an abundant bird on Laysan, and far and away the form most familiar to persons cruising in Hawaiian waters. Although so common on Laysan, Mr. Schlemmer estimates that in point of numbers it is second to *Æstrelata hypoleuca*. The greater number are congregated in a zone perhaps 50 yards wide around the lagoon, some distance seaward from the bare flood plain mentioned in the narrative. It is surprising how consistently they keep to this locality, as they are rare elsewhere on the island. This area is shared with albatrosses, rails, and in places with *Sterna lunata*, and overlaps the wide *Æstrelata* colonies. The burrows are among tall bushy grass as well as in the open among matted juncus and succulent portulaca.

While we were on the island the birds sat in pairs all day near the entrance to their homes, or if the sun grew too warm retired a short way into the tunnel, where they kept up an almost constant cooing.

Not infrequently one will observe the shearwaters cleaning out old burrows or in the act of lengthening them. I saw but one tunnel newly started, so that the number of yearly visitants seems to keep fairly constant. In digging the birds scratch with bill and feet, and with the same implements shove the loose sand and soil under their bodies, when they kick it in little jets far out behind. As they remove the sand they lie first on one side and work a foot and then shift to the other. One is sometimes startled, while standing quietly among the bushes, by being suddenly beset with little showers of sand, which on closer inspection are found to originate with some shearwater toiling into the earth. In their search for nesting sites they do not hesitate to wedge themselves into all sorts of places, apparently without thought of escape, but we never found any birds actually trapped. The burrows enter the ground at a slant and then become horizontal. They are at least 3 feet long and often very much deeper. Rarely they are only about 2 feet, and these are new, while the longer ones are the older, having been dug out by successive tenants from year to year. The birds had not yet begun to lay, and do not till early in June, according to the testimony of Mr. Schlemmer.

Their note varies. When undisturbed they utter a dove-like *khoo-whó*, which changes to a loud *khoo-ow'* as they grow excited, and finally at the height of their enthusiasm one hears only a *yow-ow'* or *oo-ow'*, quite like the nocturnal serenade of cats. It seems to be a courting song, but is decidedly unmusical.

A comparatively few at this season fly abroad during the day, but after dark they begin to move about more, and one moonlight night we found them very active and owl-like in their flight. At sea they are expert fliers, sailing with immovable wings rapidly and readily close over the waves, as well against as with the wind, and they can go across the breeze much more easily than can the albatross.

We met this species off the French Frigate Shoals, and on Necker found it nesting, but, as on Laysan, there were no eggs. The birds nest in hollow cavities of the rock, where they sit facing the wall, and when disturbed coo and yowl in familiar fashion. I suppose the *uau* (*oo-ow'*) of the native name is in imitation of the cry. No nest proper was found in any of these little caves; only a few twigs, feathers, and old bones scattered about.

The species was noted at Bird Island, where a number flew aboard, attracted by the glare of deck lights. Stomachs of these birds contained the hard parts of small cephalopods (squid, octopus, and the like). It was seen constantly at sea throughout the main Hawaiian group. It is known to breed on Kauai.[a] This shearwater ranges west across the north Pacific Ocean to Volcano Island, south of Japan,[b] Krusenstern Island, Sulphur Island, Bonin Island.

We kept four males and four females of this species. One male from Bird Island and one from Laysan have the lower parts immaculate, except for a faint smoke gray or brownish gray shading and barring of feathers on sides and flanks. In all the other specimens (3 males and 3 females) the deep brownish gray of the sides of the neck encroach in varying degrees onto the throat and jugulum and that of the sides and flanks onto the breast and abdomen. In two specimens this shade extends entirely across the throat, the feathers of the sides of neck being terminally mouse gray, edged with white, while those of the throat are white with one or two irregular bars of gray. The effect produced is a delicate vermiculation of the jugulum and a coarser herring-bone spotting of the throat. The flanks are dark in these six specimens, and in all there is a greater or less vermiculate barring of abdomen. A breeding female from Laysan has a very fine, dust-like spotting scattered over nearly all the abdomen. There is a slight variation in the bills. (Fig. 29.)

Puffinus nativitatis. *Christmas Island Shearwater.*

Puffinus nativitatis Streets, Bull. U. S. Nat. Mus., No. 7, 1877, p. 29.

The Christmas Island shearwaters were nesting on Laysan at the time of our visit. They are distributed here and there over the island, usually in the domain of *Æstrelata hypoleuca*, but not infrequently we found them among the wedge-tailed shearwaters, and again on low sand bluffs overlooking the sea. It is entirely probable that the species is much more abundant than they seem to be, for they are decidedly retiring in their habits, and prefer to lay their single egg under the densest bushes away from the hot sun. For this reason alone a large proportion would naturally escape detection.

[a] Stejneger, Proc. U. S. N. M. 1888, p. 93.

[b] Salvin, Cat. B. B. Mus., xxv, 1896, p. 371.

The egg is deposited either directly on the sand under some bush or occasionally in a mere semblance of a burrow. This burrow was never sufficient, so far as I could see, to entirely cover the bird, but seemed an expedient to gain shade in lieu of denser brush. I saw only a comparatively few of these shallow holes, none of which were more than a foot or 18 inches deep. Frequently this shearwater is found nesting under colonies of *Sula piscator*.

The white egg is usually ovate; an average specimen rather more elongate than the diagram in Ridgway's Nomenclature of Colors. One specimen in our series of twelve is bluntly elliptical ovate, and another is nearly oval. An average specimen measures 58 by 40 millimeters. The bird, on going back to her egg, pushes it under her breast with her beak, and then works the egg backward till it is entirely covered. (Fig. 41.)

The note or cry is much like that of *Puffinus cuneatus*, and is dove-like, rising in volume and pitch as the bird gathers interest or becomes more excited. When one is close the note resembles *khoo-how'* - - - ! or *khoo-oo-ow'!* The first note or two notes are made on the inspiration, the final *ow!* on expiration. Both are prolonged, and the final note is cat-like from a distance.

The species is more gentle than *Puffinus cuneatus*. We did not see the birds flying about much. They seem to be nocturnal or crepuscular in habits. One bird which I frightened disgorged a squid and some small silvery fishes.

The bills of two males are larger than those of two females. Our specimens are in fresh plumage, and the brown feathers of the breast and abdomen are tipped ever so lightly with a paler brown, so that the contour of the feather ends is seen. This very soon wears off, and in one bird is nearly absent.

We met with this shearwater off the French Frigate Shoals, but saw none on or near Necker. On our first visit to Bird Island in June it escaped detection, but at the same place in August I saw a few, so that they undoubtedly breed on the island.

Salvin[a] gives the distribution of this bird as "Central North Pacific Ocean, from Christmas Island to Krusenstern Island and the Phoenix Group."

Æstrelata hypoleuca. *Salvin White-breasted Petrel.*

Æstrelata hypoleuca Salvin, Ibis, 1888, p. 359.

This petrel is strictly nocturnal on Laysan, which was the only place where we found it. Here it occurs in great numbers, and is the most abundant species of its family inhabiting the island. The long burrows in which the birds nest honeycomb the sandy soil over all the region covered by coarse bushy grass, or from the edge of the plain surrounding the central lagoon to the divide overlooking the sea. In walking over the island one constantly breaks through the roofs of these tunnels, which makes progression tedious at times, especially if one is in haste. The burrows are quite long, 6 feet at least, and usually turn either to the right or to the left after the first few feet. They are placed very close together, so that nearly all available space in the area indicated seems occupied.

When we visited the island many young in incomplete juvenal dress had crawled out to seek shelter under a tuft of grass, as shown in fig. 30. These young had assumed the juvenal plumage on the breast, abdomen, back, top of head, wings, and tail, but the remiges, rectrices, sides of head, nape, forehead, throat, and jugulum were still downy, and the lower abdomen in most birds still retained a big tuft of pure white down. The down of the upper parts is light gray, including all the head and sides of neck.

According to Mr. Schlemmer the eggs are laid about the 1st of January, but the birds arrive in vast numbers months before. Dr. Schauinsland thus graphically describes the invasion:

"I remember most vividly the evening of the 17th of August, 1896. It was less noisy on the island than before, for the clamorous terns had reared their young, and thousands of albatrosses had left their ancestral home for the boundless ocean, which would in future be their dwelling-place. We were just leaving the little hill from where we had been looking for the sail which should take us back again to civilized countries. The golden glow of the sunset was fading away, and the slender sickle of the new moon began to shine, when our eyes, which had become well acquainted with every one of the characteristic motions of our feathered companions of the island from week-long observations, were struck by a new phenomenon. Against the dissolving evening glow was sharply traced the silhouette of a magnificent flier, which cut through the air with the keenest and at the same time most graceful movements, inaudible and almost without movement of its wings. The manner in which it dashed along was unknown to us, and we saw that a new arrival had reached our island.

[a] Cat. B. B. Mus., xxv, 1896, p. 390.

"The next morning there were more, and on the third thousands filled the air. The new guests were pretty birds, barely of the size of a domestic pigeon, but they began to domineer all over the island in such a way that the few pairs of tropic birds, terns, and others which were still breeding made way before them, as if they could not stand these noisy neighbors. They are, on land, entirely nocturnal, and at once took possession of their innumerable subterranean burrows. In the bright moonshine one could see how they were busily engaged in removing the loose sand from holes, most of which had more or less collapsed since they had left them. Loving couples selected their nests and fought hard for them against later intruders. Quarrels, fights, and clamor became unceasing; in a few days there was no spot with sandy soil where the horrid 'song' of these petrels could not be heard. Under every bush, between our luggage and cases, and, alas, also under our bedroom, their tune was raised, which stood about in the middle between that which 'drives men to madness' and the cries of newborn babies, which are only harmonious to their devoted parents. The face of the island was entirely changed!" [a]

Little could be learned of the habits of this petrel during our brief stay. We saw them come out of their burrows singly and in pairs after nightfall, and there were great numbers flying about. As we walked through the tall grass they frequently rose silently and flew a short distance to settle down soon. Many were evidently bound for the sea to feed. Their note resembles somewhat that of *Puffinus cuneatus*, and rises from a low moaning to an infant-like cry, as Dr. Schauinsland aptly describes it.

This petrel ranges over the North Pacific Ocean. [b]

Bulweria bulweri. [c] *Bulwer Petrel.*

Procellaria bulweri Jardin & Selby, Illustr. Orn., 1828, pl. 65.

We found the Bulwer petrel breeding on Necker Island in considerable numbers. Here the birds nest in rather deep, bubble-like holes in the rocks, as far from the light as possible. We found the first bird by discovering a white egg under a loose, flat rock back in a cavity. When the stone was lifted the petrel was under the far side. The favorite site, however, is a hole about 2 feet deep, with a narrow entrance, and wider cavity at the rear. These are probably bubbles in the lava. The nest, scarcely worthy of the name, consists of a few old tern feathers gathered rudely around the egg, as if merely to hold it in place. Sometimes there is no trace of a nest, and again I found a few wing bones of a tern, as though these had been used in place of sticks. We found many nests, each with one egg, or occasionally the birds had not yet begun to lay. Once we found a set of two eggs. They are a glossless pure white and differ much in shape, no two in the collection of nine being alike. Ovate is the most prevalent type, more or less acute, varying to elliptical ovate and short ovate. One egg is nearly elliptical. An ovate specimen measures 44 by 30 millimeters, another 41 by 31. An almost elliptical egg is 45 by 30.

The Bulwer petrel is quite gentle, and when first disturbed utters a penetrating but low moan something like *who! who!* dove-like in quality, but decidedly different from the *oo-ow'* of the uau kane (*Puffinus cuneatus*). On several nests we found two birds sitting side by side.

Henry Palmer found this species on French Frigate Shoals, where it was nesting under a pile of old turtle shells. He also met with it on Laysan, where we did not detect any during our stay.

[a] Drei Monate auf einer Koralleninsel, p. 49. Extract transl. in Avifauna of Laysan, p. 304.

[b] Cat. B. B. Mus., XXV, 1896, p. 409.

[c] As Rothschild in "Avifauna of Laysan," part 3, 1900, uses the name *Bulweria anjinho*, and Wilson and Evans do the same in "Aves Hawaiienses," 1899, I wrote to Dr. Leonhard Stejneger and Dr. C. W. Richmond for information on this point. Dr. Stejneger writes: "In reply to your inquiry respecting *Bulweria bulweri* or *B. anjinho*, I am able to state that the former is the only correct name. Dr. Richmond, who kindly looked the case up for me, as he has easier access to the books, informs me that not only was *B. anjinho* published a year later than *B. bulweri*, but that the diagnosis of the former is so defective that it is doubtful if it really refers to the bird in question, inasmuch as the tail is said to be 'slightly forked,' while in *B. bulweri* it is graduated or wedge-shaped. The latter name (*bulweri*) dates from 1828, the former from October, 1829."

Dr. Richmond writes as follows regarding the date of Jardine & Selby's "Illustrations of Ornithology": "Jardine & Selby's 'Illustrations of Ornithology' was issued in several parts, and until a few years ago the dates of the different parts were guessed at. In the *Ibis* for 1894 you will find a note by Sherborn giving the dates of the different installments of the work, and plate 65 (*Procellaria bulweri*) comes in part 4, which was issued in *November, 1828*."

I might add that Mr. Sherborn's references to the second series were all wide of the mark, which probably accounts for the persistent publication of 1830 as the date of *Procellaria bulweri*. Dr. Richmond, who had previously worked out the dates for this work, sent a note of correction to Mr. Sherborn, who revised the dates of the second series in answer to Dr. Richmond's "inquiries" (sic)—a delicate way of acknowledging the mistake.

At Bird Island the petrels were abundant. They flew aboard, attracted by deck lights. These birds had been feeding on fish eggs? and ctenophores or comb-jelly. During the day many were seen skimming rapidly over the water.

This species ranges over the temperate North Atlantic and temperate North Pacific oceans (Salvin).

Oceanodroma fuliginosa. *Sooty Petrel.*

Procellaria fuliginosa Gmelin, Syst. Nat., I, 1788, p. 562.

Under this name I include two petrels, one of which was obtained on Laysan and the other at Bird Island. The Laysan bird was found hurt or sickly near the lagoon, where I saw upward of a dozen dead and dried-up individuals. The Bird Island specimen flew aboard, attracted by deck lights. Both birds are immature, retaining a trace of the down. They agree essentially in respect to size and color with the description by Mr. Ridgway, published in the Catalogue of Birds of the British Museum, with the exception that the wings are shorter, which is accounted for by the immaturity of the specimens. The bird from Laysan has remarkably short wings.

The following are the measurements of the two specimens in millimeters:

No.	Sex.	Locality.	Date.	Wing.	Tail.	Fork of tail.	Culmen.	Depth of bill just in front of nostrils.	Tarsus.
43	♂ im.	Laysan	May 18	150	94	30	16	4.5	29
168	♀ im.	Bird Island	June 1	196	110	37	18	5	29

On Laysan, according to Mr. Schlemmer, this species breeds in February, and nests in burrows under scattered bowlders of old coral rock on the southwest side of the island. There was a small colony of *Puffinus cuneatus* in this place when we visited the island, so that the same burrows are occupied during the year by two species.

The sooty petrel may be said to be hardly common.

PHAËTHONTIDÆ.

Phaëthon rubricauda. *Red-tailed Tropic Bird.*

Phaëton rubricauda Boddaert, Tabl. Pl. Enl., 1783, p. 57.

The red-tailed tropic bird is fairly common on Laysan, where it nests under the shelter of bushes and not infrequently several will congregate beneath colonies of *Fregata aquila*, occupying the ground floor as it were. The bird has a vicious temper, and if one attempts to disturb or to take it from the egg, it sets up a horrible and discordant screaming, which soon grows unbearable. The sharp beak with serrated edges is not to be despised and the enraged bird will sometimes use it to good advantage. The bow'sn birds keep up their strident cries so long as one meddles with them, but if left undisturbed will soon quiet down. Whenever we inadvertently passed near one hidden under a chenopodium bush, we soon became aware of its presence by its cry of defiance. (Figs. 31, 32.)

To see these birds at their best one must watch them flying about in the bright sunshine, when their pale, salmon-pink plumage shines as though burnished, and the satiny feathers stand out like scales. The two long, red tail-feathers are possessed by both sexes, and the female is only a trifle less pink than the male. Usually when flying about they were quiet, and progressed by short, nervous wing-beats, never attempting to sail. Occasionally, however, they swooped about our heads and made the neighborhood lively.

The nest is merely a hollow in the sand, with a few grass straws and leaves gathered in the bottom. The single egg is brooded by both parents, each of which sits upon it with the wings slightly opened. The egg is particularly handsome, being thickly sprinkled with specks, spots, and even blotches of reddish brown (liver brown), in most of the specimens rather evenly distributed over the egg, but with an irregular dark area at the larger pole in some specimens. The ground color is a dirty white, almost obscured by the fine marks. Some examples have few spots, only fine sprinkling, so that the general tone of the egg at a distance is vinaceous. One specimen is almost white, while two others are very heavily washed at the blunt end with deep reddish chocolate. The eggs are ovate,

and a typical specimen measures 67 by 45 millimeters. We found one white, downy nestling, and most of the eggs were considerably incubated.

We saw only one red-tailed bow's'n bird near the French Frigate Shoals, but on Necker they were rather common. Contrary to the very pronounced nesting habits on Laysan, the species here has accommodated itself to the rocks and lays its egg in any rounded cavity. One nest I examined consisted of old torn feathers, a few stray sticks, and similar rubbish. The birds sat facing the wall, and were as noisy as usual when disturbed.

The species is scarce at Bird Island, where it was observed in August.

Among the windward islands of the group, that is from Niihau and Kauai to Hawaii, we did not observe this species, although *Phaëthon lepturus* was frequently seen. Mr. Wilson in "Aves Hawaiienses" states that "it breeds in several places in the group, especially on Kauai and Niihau, and chooses holes in almost inaccessible cliffs wherein to deposit its eggs."

SULIDÆ.

Sula cyanops. *Blue-faced Booby.*

Dysporus cyanops Sundev., Physiogr. Sällsk. Tidskr., 1837, p. 218, tab. 5.

On Laysan the masked, or blue-faced booby lives only on the sedgy slope facing the ocean, exposed to spray-laden winds and close to the booming surf. On the inner slopes of the island the species is entirely absent, being replaced by its somewhat smaller congener *Sula piscator*. We found *cyanops* most plentiful on the northeast, east, and southern exposures, where the narrow littoral slope is broadest, but on the west side, where a little bluff replaces the seaward slope, the birds are absent. The homes of these boobies are not crowded, but are scattered here and there over the greensward and from a distance are easily recognized by a little round patch of sand and the sentinel bird. Two limy, white eggs are laid on the bare sand, with usually no semblance of a nest, or occasionally there may be a little dried sedge scratched about the eggs or young. As is well known the eggs are a light blue underneath, and the coarse limy coating covers this to a greater or less extent. Sometimes the blue shows through, or is revealed by scratches made when the outer layer is soft. All the eggs we saw were very untidy. There is, of course, variation in size and shape, some eggs being ovate, and others elongate oval or short fusiform.

We found young and eggs in about equal numbers, and most of the eggs were far advanced in incubation. The young varied from about a week old down to newly hatched individuals. It is a curious fact that although there are two eggs, only one young is reared. Often all signs of the second egg were removed, as if the young had hatched and had been devoured by a parent or some marauding *Fregata*. But more frequently there would be one nestling and one egg. Sometimes this egg was spoiled, sometimes contained an embryo. In one case I found two newly hatched young, one of which had already been trampled to death. Professor Nutting saw one large nestling and one small, still alive, but I doubt if it lived long. The presence of only one young bird has been noted in the eastern Pacific at Clipperton Island by R. H. Beck,[a] and Rothschild[b] mentions the same fact for Laysan. The voracity of the bird first hatched is probably responsible for the death of the second.

The young bird nearly always keeps its head under the parent, although the greater part of its body may be exposed to the sun. Both old birds take turns in sitting on the eggs or watching the nestling. Occasionally both will be seen standing guard together, in an absurd statuesque pose, or gazing seaward or at the sky on the lookout for winged marauders. From time to time they utter a very hoarse strident cry. (Figs. 33, 34, 36.)

We derived no little pleasure on the first afternoon of our visit from watching an old bird feed the young. The young one inserts its head fairly into the throat of the parent, in a decidedly gruesome manner, and catches the disgorged food. In fact, the young one's head went so far into the parent's throat that I became solicitous for its safety. Flying-fish, swallowed whole, seem to be their favorite food, judging by remains scattered about nests and a stomach examined. (Fig. 35.)

When the old birds exchange places, one slips off the nestling and the other immediately takes its place, as if fearing an attack from a frigate bird. The boobies appear to exhibit affection for their young. I have seen them gazing at the fuzzy-white ball with evident pride in their otherwise stolid

[a] Condor, IV, 1902, p. 51.

[b] Avifauna of Laysan, p. 26.

countenances, and on one occasion saw an old bird carefully lay dry sedge over the exposed, and not too heavily feathered, hind parts of the young.

This species was commonly seen about the French Frigate Shoals, where Henry Palmer found a large colony in 1891. It is also rather abundant on Necker, nesting among the bushes on the top of the island, and also out on the bare rocks. They chose often a jutting crag, where they could obtain a good prospect of the surrounding island and sea. The few "nests" examined had young somewhat larger than the Laysan birds. The species is likewise common on Bird Island, where we saw numbers of individuals the first of June, and again in early August. On our last trip numerous birds in juvenal plumage flew near the ship.

Sula piscator. *Red-footed Booby.*

Pelecanus piscator Linn., Syst. Nat., ed. 10, I, 1758, p. 134.

Unlike its relative, the masked gannet, this species always builds in bushes, never on the ground. At Laysan it is found in colonies of scattered individuals on the inner slopes of the island, usually well down toward the lagoon. The nest is simple, scarcely more than a slightly hollowed platform composed of twigs and sticks of chenopodium, on the tops of which the structure is usually placed. In the newer nests a few leaves are scattered under the egg. These leaves were a rude index to the age of the egg, for when dry and crisp the bird had been sitting some time, but when fresh, as was frequently the case, the egg was only newly laid.

Both male and female sit on the egg, and occasionally one is seen perched on the side of the nest while the other is brooding. The birds are rather loath to leave their egg, and when disturbed ruffle their feathers and utter a very harsh cry, making use of their beaks if occasion offers. They are singularly beautiful birds despite their vicious yellow eyes, as the white plumage is set off by bright blue skin about the bill, and by coral-red feet. (Figs. 37, 38.)

The species eats squid and also fish.

Most of the nests contained a single white egg, and we saw only one or two downy white young recently hatched. The eggs, like those of *Sula cyanops*, are covered with a thick limy coating, which, scratched off in numerous places, shows the pale blue under shell. The eggs vary in size and shape, being cylindrical ovate, elliptical ovate, short ovate, and ovate, with all gradations between these contours. The dimensions vary from 71 by 40 millimeters to 59 by 43, and 69 by 35 to 60 by 39. Elliptical ovate is the most prevalent type, measuring 65 by 42 millimeters. A very small egg (53 by 34) contained no yolk.

The species is not uncommon about the French Frigate Shoals, where an immature bird foolishly lit on the bow of our steamer and subsequently found its way to the laboratory. It was in the immature plumage still. We saw numerous birds on Laysan corresponding to this specimen. Whereas the adult is pure white, except the dark grayish-brown quills and greater wing coverts, this immature bird, in much-worn plumage, has the head and neck hair brown, the feathers edged with whitish; throat the same; jugulum white; a sepia band across breast; abdomen white; back deep bister, the feathers edged with wood brown; wing coverts and tertials sepia edged with light brown; rectrices same, tipped with white; remiges brownish black. The immature individuals must belong to a late brood of the previous year.

On Necker we found the red-footed booby abundant. It nests on the top of the island in chenopodium bushes and has the same habits as on Laysan. Young and eggs were common.

The species is likewise plentiful at Bird Island. From the ship we were able to see the birds sitting on their nests in the tops of bushes. In the "Avifauna of Laysan" a plate is given of a red-footed booby nesting in a palm, labeled "Laysan," and subsequently corrected to "Lehua." Lehua is a little island off the north end of Niihau, which is as bare as a steep volcanic cone can possibly be, so that the palm does not belong there. The picture may possibly have been taken on Bird Island, where there are two little bunches of palms (*Pritchardia gaudichaudi*). When we returned to Bird Island in August (5th and 6th) I did not see any adults of this species, to be certain, but noted several immature birds.

Sula sula. *Booby.*

Pelecanus sula Linn., Syst. Nat., ed. 12, I, 1766, p. 218.

This booby was not seen on Laysan, although I looked for it assiduously. It has been reported from there by Dr. Schauinsland, who procured a specimen August 29, 1896. The bird certainly does not breed on this island, or at least not regularly, for we could not have missed it.

At French Frigate Shoals we saw a number of them, and on Necker Island the species breeds but is not at all abundant. The two eggs are laid on a level place, where there happens to be a little soil, upon a shelf of the rock. We also found rather large young in white down, and all intergradations between these and the egg. Frequently both birds sit by the nest, and they did not appear particularly suspicious. As in the case of *Sula cyanops*, only one young appears to be reared, although two eggs are laid. Of those eggs collected one of a set was fresh and the other much incubated. The eggs are either ovate or elliptical ovate and an average specimen measures 58 by 40 millimeters.

Sula sula breeds on Bird Island, and prefers the brink of the escarpment of rock on the south side. In August we saw numbers of young birds, wholly brown.

FREGATIDÆ.

Fregata aquila. *Man-o'-war Bird.*

Pelecanus aquilus Linn., Syst. Nat., ed. 10, i, 1758, p. 133.

The man-o'-war bird proved scarcely less entertaining than the albatrosses. The curious and excessively bizarre appearance of the male at this season of the year compels attention. His antics are as extraordinary as his looks, and when engrossed in the task of making himself attractive his self-absorption and apparent vanity are highly diverting. During the courting period the gular pouch of the male is enlarged, and before the brooding cares have begun he inflates it to a large size, and at the same time it becomes a bright red color. The bird looks as if there were a balloon, such as children dangle on a string, fastened to its throat.

The pouch is apparently a large air-sac, connected only indirectly with the lungs, which can not be emptied readily nor inflated instantly. It varies in the intensity of its carmine or crimson, and catching on its surface the sheen of the sky, shows at times bluish hues, or, becoming somewhat collapsed, turns a translucent orange about the sides. It is no uncommon occurrence to see a male bird sitting on the nest with the sac blown out, obscuring the whole front of the creature, only the bill and eyes appearing over the top. For hours he sits on a newly-made nest without once leaving or scarcely altering this position. But if the female appears somewhere overhead, sailing to and fro, he suddenly arouses himself from the lethargy, and as she passes he rises partially from a sitting posture, throws back his head, spreads his wings, and protruding the brilliant pouch, shakes his head from side to side, uttering a hoarse cackle. Occasionally, when the female alights near, he waves his pouch from side to side, the head being thrown well back and the wings partially spread. At the same time the long, greenish, iridescent, scapular feathers are fluffed up and the creature presents a most unusual and absurd appearance. In this posture he chuckles again and again, and rubs his pouch against his mate, who usually ignores him completely and flies away. These performances take place before the egg is laid; afterwards, the male ceases to inflate his sac. (Figs. 39, 40.)

At Laysan the birds live in colonies varying from a few pairs to many, and the nests are always built on the tops of low bushes, sometimes very close together. The species has congregated almost entirely on the eastern half of the island, and their villages are spread over the inner slope of the old atoll basin. The nests, which are sometimes so old that they have become mere masses of filth, are scarcely more than platforms of sticks, not entirely devoid of leaves, woven together loosely with morning-glory (*Ipomœa insularis*) vines. There is one pure white glossless egg, and we observed a very few newly hatched, almost naked, young. The eggs do not vary nearly so much as those of *Sula*, either in size or shape. A rather blunt ovate is the usual contour, though some are elliptical ovate and others approach short ovate. A fairly average specimen measures 72 by 50 millimeters. In some of the eggs the limy outer coating is made apparent by the egg having been scratched when newly laid; but the inner layer is white, not pale blue as in *Sula*.

Both parents take turns in covering the egg, which is a necessity, for if the nest were left without an occupant other frigate birds would quickly appropriate its material, especially if the nest were new. Consequently, even before the egg is laid, either bird holds down the property, as it were, against marauding neighbors. After the nestling is out this vigilance is all the more necessary, for if left unprotected a young bird would very likely serve as food for some watchful reprobate of the vicinity. Mr. Snyder saw an old frigate bird snatch up and fly away with a young of the same species, whose parent had been frightened off the nest. According to Henry Palmer[a] who visited the island a few

[a] Avifauna of Laysan, p. x.

weeks later in 1891, this is a very common occurrence, but the young were so scarce we considered the accidental demonstration mentioned above as sufficient evidence of the heartless trait. It is probable that the man-o'-war birds eat the young of other species also, but we did not observe anything to substantiate this. The fact that they chase other sea birds, gannets for instance, and make them disgorge their hard-earned prey is well known, but I was not fortunate enough to see them do this. One bird which I frightened excessively disgorged over the side of its nest a mass of squids, which are the staple of diet among all larger sea birds, *Sula cyanops* perhaps excepted.

When roused from the nest the birds have some difficulty in rising, especially the males with swollen throats, and will sprawl over the bushes in a very awkward manner. But once awing they are perfectly at home and sail off with ease, the cardinal "balloon" of the males swaying from side to side. Their appearance, as they soar aloft with this impedimentum, can be more readily imagined than described. I suppose there is a temptation with everyone who has observed man-o'-war birds on the wing to wax eloquent. But certainly in this art of soaring they are deserving of any meed of praise which we may bestow. To maintain any continuous sailing the albatrosses need a fresh breeze, and they always move with considerable rapidify. Not so with the frigate birds, however: on comparatively calm days they are able to rest on motionless wing or slowly to describe circles high in air. Some wind or motion of air is of course always necessary, but they seem to be able to do with a minimum amount. They frequently rise so high that one can scarcely detect them against the shimmering blue of the tropical sky. Suddenly some individual aloft takes a notion to descend, and promptly does so by a series of long leaps or swoops that make one fairly dizzy. It is a pleasant occupation to watch them soaring about the mastheads, when the peculiarly short "arm" and "forearm" and disproportionately long quills are seen to advantage; and their deeply forked tails, likewise, which help to keep them balanced, and which open and shut occasionally like a pair of shears. Their feet are small and their legs weak, so that although still totipalmate they never alight on the water, but pick up floating bits of food as they swoop down in a broad parabolic curve. They can judge distance so accurately that no disturl ance is created when the object is seized.

On Laysan this good judgment was made use of when the birds drank from a small pond. They flew back and forth, about 20 feet above the water, then suddenly darted downward in a long curve, and when directly over the surface, like a flash bent the head down, dropped the lower mandible, and scooped up a little water. I observed some with distended pouches performing in this way, and each time they came down the sac would plow a little wake.

We found man-o'-war birds at French Frigate Shoals in considerable abundance, and on a tall rock south of the shoals proper they were particularly plentiful. Also on Necker we encountered them, nesting mainly on bushes scattered over the summit, where there were large colonies. A few had nests on the rocks, generally on jutting crags. Mr. Snyder photographed a female sitting bolt upright with her wings spread out and tail bent back for a rest, apparently sunning herself. While we lay at anchor off the south side of the rock a flock of immature white-headed, brown-breasted birds sailed leisurely back and forth about the mastheads, inspecting the flapping pennant, which they occasionally tried to seize. I here saw a bird carrying a splinter of wood in an aimless way, as if uncertain of its utility, yet unwilling to release it. The stomach of one of these birds contained a flying-fish.

At Bird Island the species is abundant, nesting on bushes over the steep south slope of the mountain. On our second visit, early in August, they were still to be seen in considerable numbers.

ANATIDÆ.

Anas laysanensis. *Laysan Teal.*

Anas laysanensis Rothschild, Bull. Brit. Orn. Club, No. IV, 1893, p. XVII.

It is surprising that an islet scarcely 3 miles in its longest dimension should harbor a peculiar species of the genus *Anas*. The birds themselves are scarcely less peculiar than their distribution. Most of us picture ducks as among the wariest of wild fowl, but the Laysan teal, though not exactly tame, are at any rate quite unsophisticated. These birds congregate in greatest numbers about a little rush-bordered fresh-water pond, mentioned in the narrative. Here we could find them at any time, standing usually on a little pile of rocks near the center. When disturbed near shore they quietly swam out to their rock and sunned themselves by the hour. We saw the ducks also on other parts of

the island. Near the habitations there was a pair which probably had a nest in the vicinity. One of these used to come up to the house after nightfall and walk about like a barnyard fowl. Mr. Schlemmer said it was searching for millers.

The stomach of a male collected near the pond was gorged with small flies resembling the common housefly. Although these ducks can fly perfectly well they ordinarily did not take wing until approached within a few rods, and then never went far. They much prefer to walk, and we used to see them strolling about in pairs, or even threes. In this way they pick up their food as they go along. We never saw any teal near the ocean, and it is probable they never swim in salt water.

We were fortunate enough to discover one nest within a couple of rods of the pond, placed under a thick chenopodium bush. Six eggs of the palest green rested in a shallow bowl, formed of long dry juncus stems. The hollow was a little over 5 inches in diameter. As I wished, if possible, to secure a picture of the female, I photographed the eggs and left them till the following morning. When I returned to the nest, however, three of the eggs had hatched, one young was half out, another egg picked, and only the sixth remained whole. In shape the egg is a blunt ovate and measures 55 by 38 millimeters. Two days later (May 21) Mr. Snyder saw three old birds with broods, one of which took to the pond. I also saw a young one swimming about, the mother being hidden somewhere in the tangle of grasses. (Figs. 47, 48.)

The Laysan teal is, of all the birds on the island, the one most likely to be exterminated when the present favorable régime comes to an end. There are probably less than a hundred of this species now living. I shall not presume to say what keeps their numbers so in check, but it may be *Fregata aquila*. Cats running wild over the island would soon finish them, and the mongoose would do the same.

RALLIDÆ.

Porzanula palmeri. *Laysan Rail.*

Porzanula palmeri Frowhawk, Annals and Mag. Nat. Hist., IX, 1892, p. 247.

The Laysan rail is a wide-awake, inquisitive little creature, with an insatiable thirst for first-hand knowledge. It is one of the most naive, unsophisticated, and wholly unsuspicious birds in the whole avian catalogue. At times it is confiding and familiar in deportment, yet at others holds aloof with some show of reserve. It will occasionally hide behind a bunch of grass, as if afraid, and then suddenly come forth with entire change of demeanor and examine the intruder with critical eye. One can never tell just how he will be received by the next rail. Often they scurry away, as if pursued by a *bête noir*, but an insect will stop them in their mad career, and, having partaken of the interruption, they seem to forget their former fright and walk about stretching their necks in a highly inquisitive manner. It is evident that they are incapable of pursuing a train of thought for more than an instant. Their ideas seem to flash by in kaleidoscopic succession and within a minute they make as many false starts as a healthy monkey. One can scarcely imagine more amusing and foolish little birds than these.

The rails are everywhere on Laysan in great numbers. Nearly every bunch of grass seemed to harbor a pair. They probably have no enemies of any importance, and the only check to their increase is space and food supply. A man-o'-war bird may pick one up now and then, but I did not observe this. Yet the rails like to slink about in the shade of grass tussocks, or bushes, much in the same way that a chipmuck seeks the shadow of a log in preference to crossing a bright, sunny space. This trait suggested the idea that they might have winged enemies. However, if business calls, the crakes exhibit no reluctance to come out into the sunlight, especially after food, and perhaps it is the hot sun that causes them to retire to cooler byways.

The best time to observe the rail is during the morning or evening hours. Even at noon there are a great many abroad and they are only comparatively less abundant. They spend the greater part of their time creeping mouse-like in and out of nooks and crannies, as if trying to satisfy their genius for exploration. Old petrel burrows fallen in, low-bending bushes, and grass tufts are searched with care and precision in this unending quest. As they walk their heads are thrust forward from side to side, the very acme of inquisitive interest. If I stretched out on the ground with my head under a bush, and viewed the landscape from the rail's point of view, in a very short time one would appear and fix its bright red eyes on me, as if doubtful of the propriety of pursuing acquaintance. They used sometimes to come up and peer at my shoes, with one foot poised in air like a barnyard fowl.

Scarcely a thing escapes their notice. The smallest spider or beetle is snapped up with as much avidity as a more conspicuous seed. We caught all our specimens with an ordinary dip net. Usually it was merely necessary to place the net on the ground edgewise, when presently a rail would make its appearance and proceed to examine the new phenomenon at close range. Sometimes they would fairly walk into the net.

In strolling through the brush we could hear them calling on all sides. Their "song" is a plaintive, high-keyed little rattle, which resembles remotely an alarm clock with a muffled bell or pebbles ricocheting on a glass roof.[a] I have seen them standing under bushes in the shade rattling away in this manner with swollen throats and bills slightly opened. I once saw two approach each other with feathers erect, and when close together begin rattling in each other's face. Then they suddenly ceased and slunk away in opposite directions. At the house the little rails walked about the piazza in search of food, with far less fear than the chickens, and while Mr. Snyder and I were preparing specimens it was no uncommon event to have a rail under our chairs in unobtrusive search for fallen bits of meat. They took no notice of the shearwaters and albatrosses. I observed two in a lively serpentine chase about a young albatross's legs, the big creature appearing like an uncouth mammoth above the trim little rails.

They do not seem to exhibit any desire to fly, probably having learned from experience that their wings are no longer to be relied upon. I have only seen them spread their wings when hopping up to a perch or when running fast, and then they made no attempt to rise off the ground. Their food consists of small insects, seeds, green material, and eggs. Their beaks are weak, and I doubt if they can break any seabirds' eggs, except the thinner shelled ones of the terns. I did not myself see the rail actually puncture an egg, but in the "Avifauna of Laysan," the following note from Henry Palmer's diary is of interest. "While out this morning both my assistant and I saw a little rail break and eat an egg. We had disturbed from its nest a noddy (*Anous*). Immediately the rail ran up and began to strike at the egg shell with its bill, but the egg being large and hard he was quite a long time before making a hole. The rail would jump high into the air, and come down with all its force on the egg, until it accomplished the task, which once done the egg was soon emptied. By this time the tern came back and gave chase, but in vain." (Pt. 1, p. x.)

Mr. Snyder soon found that he had only to break a tern's egg and place it in the open, when a rail would appear and begin to eat it. In this way it was not difficult to secure good photographs. Porzanulas lurk about the outskirts of tern settlements all the time, and I had once to frighten one from a tropic bird's nest while attempting to photograph the egg. I also saw a rail ruffle its feathers and rush at three telespizas, driving them from a *Sterna* egg on which they were feeding. The rail then set to and finished the repast, dragging the embryo about in a vain attempt to swallow it. With such habits, it is difficult to see how these creatures can ever seriously be at a loss to find food. (Fig. 45.)

We found the rails' nests in two different situations, which, however, were fundamentally alike. Among the tangled and matted juncus, not far from the lagoon, the nests were very abundant. One had only to walk along and watch where the rails ran out from between the stems, when the nest could be easily found. It is placed on the ground at the end of a tunnel or runway, about 5 or 6 inches long, hollowed out of dried juncus leaves, and is a roundish cavity lined above and on all sides, except the little entrance way, with soft dried stems. The eggs are deposited in a little bowl-shaped hollow, about four inches in diameter. We found several sets of threes and a few of twos. The eggs are large in proportion to the bird, a typical specimen measuring 31 by 21 mm. They do not vary more than a millimeter from this size. Occasionally one is slightly longer and wider. In contour they are bluntly ovate or elliptical ovate. (Figs. 46, 52.)

The ground color is a pale olive buff, closely spotted with pale clay color or raw sienna, and faint lilac gray. The maculations are distributed fairly evenly over the egg, but in some specimens seem more crowded at the broader end. The clay color is brightest and seems to predominate. The specimens vary in the relative closeness and size of the spottings, the flecks being larger and more scattered in a few examples. None of our specimens present the creamy buff ground-color mentioned by Rothschild, or figured in his "Avifauna of Laysan." Ours are distinctly greenish. One egg in the collection instead of being smooth is decidedly rough all over, and the spots are crowded to the larger end, being made indistinct by a final layer of lime.

[a] The latter comparison is made by Mr. Frowhawk, Annals and Mag. Nat. Hist., IX, p. 248.

The rails also build their nests near the ground in big grass tussocks. In this position the nest is usually more pretentious, being hollowed out of a mass of dried grass, stems, and leaves, and is lined with finer shredded stems, mixed with a small amount of down from young albatrosses. Such nests are commonest along the border of the bushy grass area near the lagoon. Whenever visited, the few nests always contained old birds. As the greater part of the rails collected were males, it is probable that the females were keeping rather close to home. We found no young, and all the eggs collected were fresh. The young apparently begin to hatch about the middle of June.

The following episode illustrates very forcibly the fearlessness of these rails. While photographing a nest I propped back the mass of juncus stems which obscured it. The camera was only 2 feet away, and during the adjusting of apparatus the rail crept onto the nest and energetically began to cover herself with the soft lining. After photographing her several times, I lifted her off, but almost at once she slipped back again and settled down contentedly. Then with the dark cloth I persuaded her to retire to the tall grass near at hand. I hastened back to the camera, but on turning perceived my rail skipping across the flattened juncus in hot pursuit, and I was able to make only a hasty inspection of the ground glass before she had settled on the nest again. (Fig. 44.)

Porzanula palmeri is peculiar to Laysan. Its appearance strongly suggests a pale brownish *Porzana jamaicensis*. It is highly probable that the Laysan bird originated from some form closely allied to *jamaicensis*, if not from the identical species. *Pennula*, of the island of Hawaii, presumably had a similar origin from accidental migrants.

Though provided with wings, the Laysan bird has lost the power of flight, because its change of habits and the proximity of food in the colonized island have made the use of wings no longer necessary. Why the original migrants never left the island, as the golden plovers do now, is difficult to conjecture, unless, driven on by the strong northeast trades, they were so completely worn out and lost that they never cared to abandon the welcome land. This suggests that the original colonists may have been immature birds which joined flocks of more or less regular migrants to the Hawaiian group.

We brought away 16 specimens—10 males and 6 females. These present no marked variation, with the exception of one female, which is remarkably paler than the other specimens, besides possessing a stouter bill and larger legs and feet. In the ordinary birds the top of head, back, scapulars, sides, and flanks are sandy brown, marked on head and back with very dark-brown lanceolate shaft streaks. The outer edges of the feathers of the back and flanks are also sparsely streaked with white. The wings are the same color as back, except that the shaft streaks are lighter or almost wanting. The lower surface, sides of head, and a line over each eye are slaty gray, rather deep in the less worn specimens, and occasionally brownish about the breast from an infusion from the sides of neck. The abnormal specimen has the ground color of the top of head, back, etc., a cream buff, very pale on the wings. The streaks are represented by illy defined and uneven spots of light wood or brocolli brown, which are darker and more definite on the head. The under parts are conspicuously paler than those of the normal bird and the bill and feet are paler. This specimen was taken by Prof. C. C. Nutting, and was the only unusual individual noted, although we must have seen many hundred birds at close range. The size of an average rail is: length about 150 mm.; wing, 54; tail, 24; culmen, 19; middle toe, 34.

It is of the utmost importance that neither the mongoose, cat, or pig ever be taken to Laysan. The first two particularly would make short work of this most interesting bird. So long as the island is in as good hands as at present, this will not happen. It is likely to be brought about by ignorance rather than by malice. One can easily see how the pig might be taken ashore for food and eventually run wild to the almost certain destruction of the sea-bird population.

SCOLOPACIDÆ.

Heteractitis incanus. *Wandering Tatler; Ulili.*

Scolopax incanus Gmelin, Syst. Nat., I, ii, 1788, p. 658.

On Laysan this bird was the least common of the migrants. We generally saw a few every day wading in the shallow water of the lagoon, gleaning small flies and possibly brine shrimps (*Artemia?*) also. Usually the species was seen alone. I saw also one or two on Necker Island, feeding among the rocks just above the surf.

In "Birds of the Hawaiian Islands," p. 92, Mr. Henshaw says: "The ulili is a permanent inhabitant of the Hawaiian Islands, frequenting the rocky shores of all members of the group, as, indeed, it does of the Pacific islands generally. * * * Apparently the ulili never nests on the islands, and about

April or May the greater number accompany the plover in their northern flight. Before they depart, many of the outgoing ulili assume the barred plumage, which is characteristic of the nuptial season. While most go, many remain, the latter being the immature birds and the weaklings. At all events, those that remain retain the immature or winter dress and show not the slightest inclination to breed.

"About the middle or the latter part of August the return migrants begin to appear, and it is noticeable that the first comers are adults, chiefly males and still in nuptial dress, which, however, is now somewhat worn and faded. Very soon after their arrival they begin the fall molt, and by the middle of September individual birds are to be found that show but a few barred feathers and have nearly donned the full winter suit."

Our specimen, Laysan, May 18, is in breeding plumage.

Numenius tahitiensis. *Bristle-thighed Curlew; Kioea.*

Scolopax tahitiensis Gmelin, Syst. Nat., I, ii, 788, p. 656.

We found the bristle-thighed curlews on Laysan in small flocks, which usually either stayed around the fresh-water pond or scattered over the sedgy slopes near the sea to feed. They were fairly tame and allowed us to approach them, and when frightened did not fly any great distance. None of these birds were breeding. Speaking for Hawaii, Mr. Henshaw says:

"I feel sure that the large majority of these curlew make their appearance in September and October, and I have little doubt that they come from Alaskan breeding-grounds with the kolea (*Charadrius dominicus fulvus*) and the akekeke (*Arenaria interpres*). Yet I am not prepared to assert that the kioea does not at least occasionally nest upon the islands." (Fig. 42.)

CHARADRIIDÆ.

Charadrius dominicus fulvus. *Pacific Golden Plover; Kolea.*

Charadrius fulvus Gmelin, Syst. Nat., I, ii, 1788, p. 687.

These plovers were common on Laysan, where they were found in flocks near the lagoon. I noted a few also at Bird Island. All were in the winter plumage.

According to Mr. Henshaw, the kolea leave Hawaii for Alaska in April and May and the first-comers return about the middle of August. A certain proportion of immature birds and cripples remain the entire summer in the islands.

APHRIZIDÆ.

Arenaria interpres. *Turnstone; Akekeke.*

Tringa interpres Linn., Syst. Nat., ed. 10, I, 1758, p. 148.

This species was abundant on Laysan, especially near the lagoon, where it was to be seen in flocks at all times during our stay. I saw also a few on Necker Island.

Mr. Henshaw writes:

"The first stragglers put in an appearance about the middle of August. In 1900 I shot some twenty of these first-comers, and to my great surprise found all of them plump and in fine order for the table, while some were very fat indeed. All these birds, with one exception, were fully adult, and the majority were males. Moreover, they were in much the same plumage as when they left for Alaska in May; that is, they were in the red and black plumage, characteristic of the nuptial season. The young birds did not begin to appear till at least a fortnight later, and when they came were thin and poor."[a]

DREPANIDIDÆ.

Himatione freethi. *Laysan Honey-eater.*

Himatione fraithii Rothschild, Annals and Magazine Nat. Hist., x, 1892, p. 109.

The honey-eater is the least abundant of the Laysan land birds. It is by no means rare, however, for in a short walk we were always able to see plenty of them. Their bright scarlet plumage renders them especially conspicuous as they flit about amid the soft green of the chenopodium bushes, and very

[a] Birds of the Hawaiian Islands, 1902, p. 87.

attractive creatures they are on such a curious island as Laysan. The species is peculiar to the islet, but is closely related to the apapane (*Himatione sanguinea*), found throughout the main Hawaiian group. From this form the Laysan bird differs in its shorter bill and lighter colors, being a scarlet vermilion, brightest on crown, with abdomen sepia, under tail-coverts very pale brown, primaries and tail dark sepia, almost black, edged with buffy, and secondaries brown edged with buffy and vermilion. On the other hand the apapane is a dark crimson, and the primaries and tail are black, the belly white.

This brilliant little bird is found all over the island, but is most abundant in the interior among the tall grass and low bushes, bordering the open stretches near the lagoon, where all the land birds seem fond of congregating. Its favorite nesting-place is this same area, and the proximity of broad patches, acres in fact, of a prostrate succulent portulaca with yellow and a sesuvium with pink flowers has many attractions for the honey-eaters. Here they may be found throughout the day *walking* around after small insects or drinking honey from the blossoms. The brush-like tongue of the himatione renders the gathering of honey an easy task. It is not uncommon to see one go from flower to flower and insert its bill between the petals of a nearly blown bud with a certain rapidity and precision which suggests a hummingbird, except of course the fact that the himatione is on its feet.

I have observed them catching tiny, green, and hence protectively colored, caterpillars from *Chenopodium sandwicheum*, a plant very abundant in the interior of the island. They are also fond of a small brownish-gray moth or "miller," which abounds on the island to the point of distraction. While we were at lunch, on several different occasions, a himatione flew in and extracted moths from a crack between boards. It then grasped the miller with one foot, after the manner of a bird of prey, clinging with the other to the rough board wall, and ate the soft parts. After a few moments the still fluttering victim was released, and the destructive search for moths resumed. It became evident that the millers, relieved of important parts of their anatomy, did not thrive after such treatment.

The nests proved more difficult to find than those of *Acrocephalus*. In fact we discovered only one, placed in the middle of a grass tuft about 2 feet from the ground. This contained but a single egg, though a nest which Mr. Schlemmer gave to us contained four. The structure is loosely made of fine grass and rootlets, and the bowl, $2\frac{1}{4}$ inches across by $1\frac{5}{8}$ deep, is lined with fine rootlets and brown down from young albatrosses (*Diomedea immutabilis*). There are no white feathers in the lining, thus making the structure at once distinguishable from the nest of the miller-bird. The ovate egg is pure lusterless white, blotched and spotted at the large end with grayish vinaceous, and with fewer light and dark spots of Prout's brown. A typical egg measures 18 by 13.75 millimeters. (Fig. 51.)

The sexes are alike. Seven specimens without regard to sex are somewhat lighter than six others, or at least have more yellow in the brilliant scarlet vermilion. It is not improbable that the first set are birds of the previous year, while the deeper colored ones are in the fully adult plumage. The bill, wings, and tail of the females are a trifle shorter than those of the male specimens. The plate in Rothschild's "Avifauna of Laysan" represents this species far too pale and gives an erroneous idea of the color of the bird.

Telespiza cantans. *Laysan Finch.*

Telespyza cantans Wilson, Ibis, 1890, p. 341, pl. IX.

The Laysan "finch" is quite fearless and unsuspicious. It is also saucy to a marked degree, and ignores the presence of man when he is peaceably disposed. One can not walk anywhere without encountering them singly or in little flocks, diligently searching for food among the bushes, or out in the open. When disturbed they eye the intruder with interest or half in doubt and utter their low, mellow, linnet-like call. They do not fly far, but prefer to alight soon, and run along the ground, or elude pursuit by suddenly crouching under a grass tussock.

They are not particular as to food, but are fond of the soft parts of grass stems, tender shoots of bushes, seeds, and especially of eggs. I saw a pair fly to the egg of a *Sterna lunata* immediately after the bird had been disturbed by my approach. One of them opened the egg with a few strokes of its beak and began to feed at once, although I was hastily adjusting a camera only a few feet away. Nor did the removing of some rocks which obscured the view bother them greatly, for they only hopped out of reach and watched the process with equanimity, resuming their repast as soon as I had finished. But presently a rail appeared and angrily drove them off, appropriating the egg for himself. The "finches" were common in the vicinity of the house, and hopped about the piazza in a very familiar way. While I was preparing specimens one came several times and lit on a table within a few feet and explored my belongings.

The *Telespiza* is the best songster on the island, and a number were captured by officers and seamen of the *Albatross* for cage birds. One which was kept in the laboratory on board made such good use of his vocal powers that it was sometimes necessary to give him more space on deck for the performance.

The favorite nesting site is in the middle of a big tussock of grass, somewhat nearer the ground than the situations of the *Himatione* and *Acrocephalus* nests. The species also builds in chenopodium bushes. We found several nests in grass clumps bordering the open near the lagoon—a location very popular with both himationes and miller-birds—and in each case the nest was wedged in the center of the tussock, well hidden by the tall grass stems. It is made of rootlets, twigs, and coarse grass, and the whole structure is rather loosely put together. The shallow cup is $2\frac{3}{4}$ inches in diameter and is lined with shredded grass.

Three eggs are laid, though we found some nests with incomplete sets of two. All were fresh. A rather large specimen measures 24 by 18 millimeters. It is somewhat bluntly ovate, of a lusterless white, with small blotches and spots of light sepia and lilac gray, crowded toward the blunt end and very sparingly present on the acute half. Another egg of the same set of three is smaller, measuring 22.5 by 17.5 millimeters. The third egg is a trifle smaller still, and has the spotting distributed evenly over the whole surface. An example from a set of two is plentifully blotched with lilac gray at the blunt end and sparsely spotted with dark Prout's brown, giving it a rather unusual appearance. Some eggs have the spots relatively large (2 millimeters in diameter); in others they are very small. Occasionally an egg presents at the blunt end one or two dark lines. There is great variation in size and color, and some eggs are as small as 21 by 15 millimeters.

We collected 24 individuals of this species. The adult and subadult plumages are quite different, and led Mr. Walter Rothschild to describe the fully matured bird as *Telespiza flavissima*. For descriptions of this species see any of the works cited in the introduction, especially the "Avifauna of Laysan," which gives excellent colored plates of both adult (*sub nomine* "*flavissima*") and "immature" plumages (*s. n.* "*cantans*"). Of the 24 specimens 11 are adult males in the bright yellow plumage, with back not streaked. One adult male is about midway between the two plumages, having assumed the "yellow stage," except on back, wings, and tail. Five other males are in the immature streaked plumage, but one is much yellower than the others. All these five are much more worn than birds in the yellow plumage. All the sitting birds I noted were in streaked dress, similar to the one shown in the photograph. (Figs. 49, 50.)

Of seven females three are in the immature streaked stage and are all a trifle paler over the yellow area than males in a similar stage. The other four are halfway between the "adult" and the "immature" stages. Had not Mr. Rothschild expressly stated that the sexes are alike in fully adult plumage, I would have considered three of these birds in the final plumage. The back is streaked like the immature males and top of head to less extent. The yellow of rest of head, and breast, which is not streaked, is more greenish than that of the adult male and less extended over abdomen and flanks. The flanks are light brownish and sparsely streaked. If the adult female is exactly like the male, these four specimens form a beautiful connecting link between the two plumages. We collected no females similar to the adult males. I believe the juvenal plumage is worn a year, till after the first nesting season, when the intermediate phase is assumed. Just how long that is worn is hard to tell, but I doubt if the fully adult plumage is gained till the bird is in its third year.

SYLVIIDÆ.

Acrocephalus familiaris. *Miller Bird.*

Turtare familiaris Rothschild, Annals and Magazine Nat. Hist., x, 1892, p. 109.

The warbler is locally known as the miller bird on account of its fondness for "millers," or grayish brown moths, which abound on Laysan. It is peculiar to Laysan Island, and singularly enough the genus is not found in the Hawaiian group proper, to the eastward.

Acrocephalus "comprises a well-marked group of birds familiarly known as Reed-Warblers, and is distinguished by the possession of a very minute bastard primary and a moderately rounded tail. The bastard primary is so minute that in adult birds it does not usually extend as far as the primary coverts. In birds of the year, and in one or two species slightly aberrant in this respect, it is usually somewhat longer, occasionally extending beyond them. * * * The bill is typically large,

depressed, and broad at the base, with moderately developed rictal bristles. * * * The general color of the plumage is more or less uniform brown, sometimes olive brown, sometimes russet brown, gradually fading, as the plumage becomes abraded, into a neutral brown or dust brown, not inaptly described as *museum* color.

"Most of these birds are migratory and molt twice in the year, shortly before each journey. Their breeding range extends over the whole of the central and southern Palæarctic Region, but only one species extends as far north as the Arctic circle. They winter in the tropical regions of Africa and Asia, and are especially common in the islands of the Malay Archipelago. Two species apparently migrate south instead of north to breed, and resort to the swamps of Australia for that purpose. Two other species appear to be nonmigratory—one having found a permanent home in South Africa and the other[a] in the Caroline Islands of the Pacific." [b]

It is not difficult to conjecture how Laysan became colonized by the original *Acrocephalus*, as the Caroline Islands form a convenient mid-station from the Malay Archipelago. It is singular, however, that the genus did not secure a foothold in the large islands of the group—Kauai, for instance. *Acrocephalus syrinx* is said to occur only on Ponapé, one of the most easterly of the Caroline Islands, where it is resident. Thus, in a genus of marked propensities for migrating, it is of interest to find a few species so restricted and conservative, as it were.

The miller bird is one of the most abundant of the four strictly land birds peculiar to Laysan. In the cool of the morning or in late afternoon it is seen to best advantage, for then it is very active and at times musical. During the heated portion of the day, following the custom of our wood warblers of North America, it retires, to remain hidden among bushes or in the tall tufts of grass where its nest is made. The species, like others on the island, is quite fearless. One has no difficulty in approaching close to the active little creatures, especially near the nest, though, as is natural, they evince some doubt at first. With a little patience I was able to secure a photograph, although neither myself nor the camera, within a few feet of the nest, were at all concealed. (Fig. 43.)

Acrocephalus always appears busy. It is fond of moths and other insects, and drags the former from their hiding-places with much skill. It is not averse to the habitations on the island and may be seen with the himationes assiduously hunting for millers about piazzas and outhouses, prosecuting the search even into the rooms. One of its favorite feeding-places is over stretches of prostrate portulacas, near the lagoon, where it gleans small caterpillars from the herbage in considerable numbers.

They nest usually in big tufts of bushy grass, and like the other land birds congregate in greatest numbers along the inner edge of the bush-grass area near the lagoon. We discovered only two nests with eggs, but many empty ones apparently just ready for eggs. Each nest was placed in the middle of a large bunch of grass about 2 feet from the ground. The structure itself is composed of dried grass stems and blades, fine rootlets, white albatross feathers. The bowl is $1\frac{3}{4}$ inches wide by the same depth, and the diameter of the mouth is somewhat less than that of the interior, so that the edges of the cup overhang a little. It is lined with fine rootlets, shredded grass, and white albatross feathers, the last being a very characteristic feature of all nests, so that the miller birds probably began very long ago to make use of this convenient material. Occasionally a trace of down was found on the inside. The outer portion of the nest is rather loosely held together, and forms a globose mass $3\frac{1}{2}$ inches in diameter.

The eggs differ considerably both in size and coloration, one being as small as 19 by 14 mm. and another as large as 22 by 15 mm. The ground color varies from very pale olive buff through greenish white to almost pure white. In one specimen the markings are olive blotches and spots of various intensities crowded at the blunt end, and likewise very tiny lines and specks scattered all over the egg. Another example is paler, blotched with olive and drab, and with minute specks. Two out of the five eggs lack the tiny specks.

[a] *Acrocephalus syrinx* (Kittlitz) Ponapé.

[b] Cat. Birds Brit. Mus. (Seebohm) v, 1881, p. 87. (Written before *Acrocephalus familiaris* was discovered.)

APPENDIX.

The following are additional irregular visitants recorded from Laysan by Dr. H. Schauinsland (*Drei Monate auf einer Koralleninsel*, Bremen, 1899) and quoted in Rothschild's *Avifauna of Laysan*, Bryan's *Key to the Birds of the Hawaiian Group*, and Henshaw's *Birds of the Hawaiian Islands*. Schauinsland's names are in brackets (l. c., p. 101). Schauinsland did not list *Anas boschas*, but a specimen secured by him is recorded by Rothschild. Starred species were represented by specimens.

**Larus glaucescens* Naum. [*Larus glaucus* Brun.]
**Phalacrocorax pelagicus* Pall.
**Anas boschas* Linn.
**Anas americana* Gmel.
**Anas carolinensis* Gmel. [*Nettion crecca.*]
Anas querquedula?? Linn. (probably *discors*). [*Querquedula circia.*]
**Spatula clypeata* (Linn.).
**Dafila acuta* (Linn.).
**Clangula albeola* (Linn.).
Crymophilus fulicarius (Linn.).
**Tringa acuminata* (Horsfield).
Tringa pacifica (Coues). [*Tringa* (*Pelidna*) *americana* Cass.]
**Calidris arenaria* (Linn.).
**Limosa lapponica baueri* (Naum.). [*L. novæ zealandiæ* Gray.]

Since the foregoing report was written Mr. William E. Safford, of the U. S. Department of Agriculture, has kindly examined and identified the plants collected on Laysan. The following is the list:

LAYSAN:
Cenchrus calyculatus Cav.
Sporobolus virginicus Kunth.
Eragrostis cynosuroides (Retz.).
Cyperus hypochlorus Hillebrand.
Santalum freycinetianum Gaud.
Chenopodium sandwicheum Moq.
Amarantus viridis L. (*Euxolus viridis* Moq.)
Boerhaavia tetrandra Forst.
Sesuvium portulacastrum L.
Portulaca lutea Sol.

LAYSAN—Continued.
Capparis sandwicheana D'C.
Tribulus cistoides L.
Ipomœa insularis Stend.
Heliotropium curassavicum L.
Scævola kœnigii Vahl.

NECKER ISLAND:
Sesbania tomentosa Poiret.
Portulaca lutea Sol.
Chenopodium sandwicheum Moq.

LELAND STANFORD JUNIOR UNIVERSITY,
June 1, 1903.

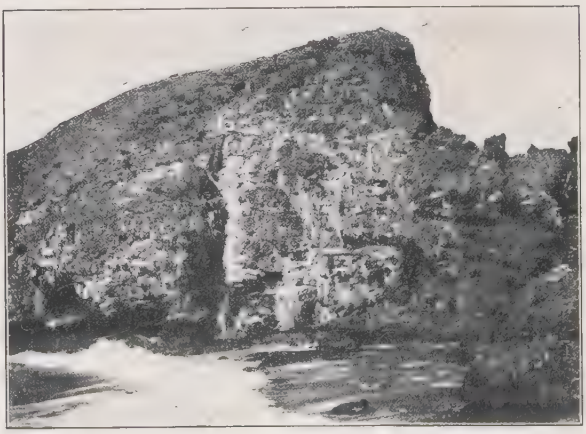
1. SOOTY TERN (STERNA FULIGINOSA) AND NEST.

2. CUSTOMARY ACTIVITY OVER A LARGE COLONY OF SOOTY TERNS.

3. PORTION OF A SOOTY TERN COLONY.

4. CHARACTERISTIC VIEW IN LARGE COLONY OF SOOTY TERNS.

5. LOOKING NORTH OVER LAYSAN ISLAND, SHOWING WEST SHORE OF LAGOON



6. COVE, NECKER ISLAND, SHOWING HIGHEST PEAK, 300 FEET

. GRAY-BACKED TERN (STERNA LUNATA) AND YOUNG, SHOWING NESTING SITE AMONG LOOSE PHOSPHATE ROCK.

8. CHICK OF STERNA LUNATA.

9. HAWAIIAN TERN (MICRANOUS HAWAIIENSIS) ON NEST.

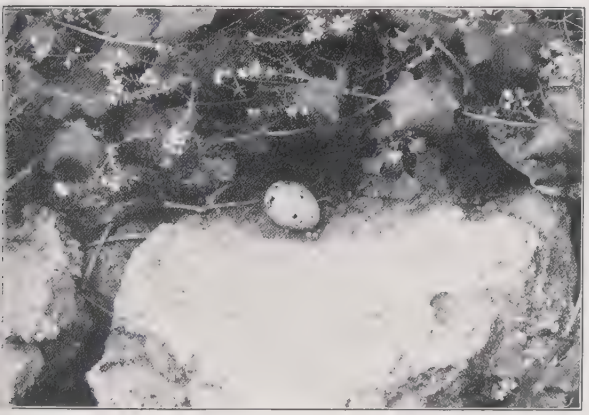
10. HAWAIIAN TERN ALIGHTING ON ITS NEST.

11. COMPANY OF MICRANOUS HAWAIIENSIS RESTING ON BUSHES NEAR THE SHORE.

12. THE NODDY TERN (ANOUS STOLIDUS) AND NEST.

13. WHITE TERNS (GYGIS ALBA KITTLITZI) NEAR THE "NEST."

14. NEST OF NODDY (ANOUS STOLIDUS).



15. CHARACTERISTIC "NEST" OF GYGIS, A BARE LUMP OF PHOSPHATE ROCK.

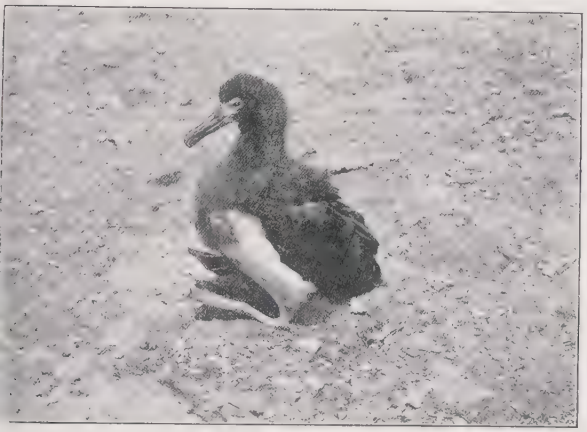
16. ANOTHER "NEST" OF GYGIS, THE BARE LIMB OF A CHENOPODIUM BUSH.

17. CHICK OF GYGIS ALBA KITTLITZI, ABOUT 3 DAYS OLD.

18. THE WRITER INTERVIEWING CHIEF CITIZENS OF LAYSAN.

19. VIEW OF A LARGE COLONY OF LAYSAN ALBATROSSES (DIOMEDEA IMMUTABILIS); MOSTLY YOUNG BIRDS.

20. A CORNER IN ONE OF THE COLONIES OF DIOMEDEA IMMUTABILIS.



21. PORTRAIT OF A YOUNG LAYSAN ALBATROSS.

22. DIOMEDEA IMMUTABILIS FEEDING ITS YOUNG—FIRST STAGE. THE YOUNG ASKING FOR FOOD.

23. SECOND STAGE IN FEEDING YOUNG—OLD BIRD STARTING TO DISGORGE.

24. FINAL STAGE IN FEEDING YOUNG—ARRIVAL OF BREAKFAST.

25. DIOMEDEA IMMUTABILIS; FIRST STEPS IN FAVORITE DANCE AND "SONG."

26. SECOND STEP IN THE ALBATROSS DANCE.

27. FINALE OF DANCE—THE DUET.

28. A MORE COMMON ENDING OF DANCE—ONE "SINGING" THE OTHER SNAPPING BEAK.

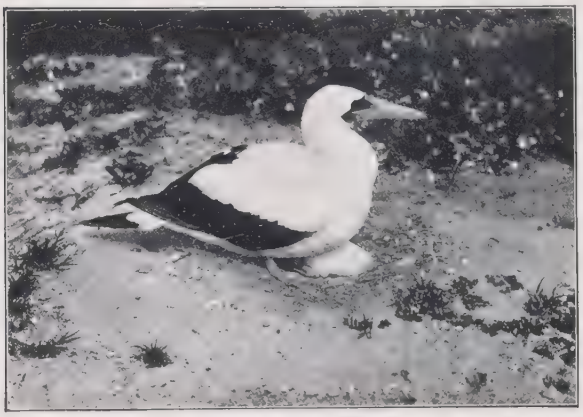
29. A PAIR OF WEDGE-TAILED SHEARWATERS (PUFFINUS CUNEATUS).

30. YOUNG OF ÆSTRELATA HYPOLEUCA.

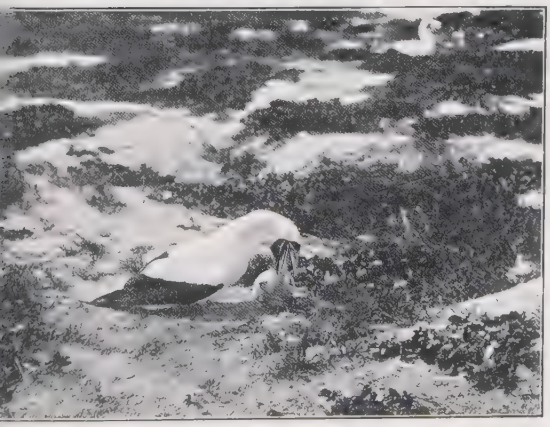
31. RED-TAILED TROPIC BIRD COVERING CHICK.

32. RED-TAILED TROPIC BIRD (PHAËTHON RUBRICAUDA) ON NEST.

33. PAIR OF SULA CYANOPS GUARDING YOUNG.



34. BLUE-FACED BOOBY SULA CYANOPS) AND YOUNG.



35. BLUE-FACED BOOBY FEEDING YOUNG.

36. SULA CYANOPS GUARDING EGGS.

37. RED-FOOTED BOOBY (SULA PISCATOR) ON NEST.

38. RED-FOOTED BOOBY.

39. MALE MAN-O'-WAR BIRD (FREGATA AQUILA) WITH INFLATED GULAR POUCH.

40. MAN-O'-WAR BIRDS; FEMALE IN FOREGROUND, TWO MALES BEYOND, ON NESTS.

41. CHRISTMAS ISLAND SHEARWATER (PUFFINUS NATIVITATIS) ON NEST.

42. BRISTLE-THIGHED CURLEWS (NUMENIUS TAHITIENSIS).

43. MILLER BIRD (ACROCEPHALUS FAMILIARIS) AND NEST.

44. LAYSAN RAIL (PORZANULA PALMERI) ON NEST.

45. LAYSAN RAIL EATING A TERN'S EGG.

46. EGGS OF LAYSAN RAIL.

47 NEST AND EGGS OF THE LAYSAN TEAL.

48. NEWLY HATCHED YOUNG OF THE LAYSAN TEAL.

49. LAYSAN FINCH (TELESPIZA CANTANS) AND NEST.

50. LAYSAN FINCH.

51. NEST OF LAYSAN HONEY EATER (HIMATIONE FREETHI).

52. NEST OF LAYSAN RAIL IN GRASS TUSSOCK, VIEWED FROM ABOVE.

NOTES ON A PORPOISE OF THE GENUS PRODELPHINUS FROM THE HAWAIIAN ISLANDS.

By FREDERICK W. TRUE,
Head Curator of the Department of Biology, U. S. National Museum.

PORPOISE, PRODELPHINUS ATTENUATUS (GRAY). LENGTH, 6 FEET.

NOTES ON A PORPOISE OF THE GENUS PRODELPHINUS FROM THE HAWAIIAN ISLANDS.

By FREDERICK W. TRUE,
Head Curator of the Department of Biology, U. S. National Museum.

During the investigations carried on under the direction of Dr. Jordan and Dr. Evermann by the U. S. Fish Commission steamer *Albatross* in the Hawaiian Islands in 1901, two specimens of a porpoise were obtained at Honolulu. The two heads, together with the pectoral fins, dorsal fin, flukes and a drawing of one of the specimens, made by Mr. A. H. Baldwin, June 7, 1901, were turned over to me by Dr. Jordan, with the request that I should report upon the material.

A preliminary examination of the heads showed that they belonged to a species of *Prodelphinus*. After carefully measuring the heads and taking notes on the coloration, I had the skulls extracted and cleaned. The specimen consisting of the head alone was numbered 112832, U.S.N.M., and the one comprising the head, pectoral and dorsal fins, and flukes, 112833, U.S.N.M. Plate 1 represents No. 112833.

No. 112832, U.S.N.M., head.—The skin of the head is cut off about 2 inches behind the eye. Light yellowish-gray color from farther back and below runs forward to about the line of the eye (on the right side) where it is quite abruptly cut off by a darker tint which goes forward nearly to the stop.[a] The same occurs on the left side but is much more obscure. The darkest of these tints is still lighter than the blackish color which occupies the center of the head from the stop backward. This blackish color forms a triangular median area with the apex at the stop. On the right side over the eye its margin is $2\frac{1}{2}$ inches above the eye. The snout proper is blackish, except on the edges, where it is irregularly yellowish white with small, distinct, irregularly placed, quite black spots. A narrow band, quite black, starts from the stop, soon divides, and, passing back, the two divisions inclose the eye. The two divisions subdivide into two or three narrower lines with light lines between them. A similar black and a whitish fine line pass from the stop to the corner of the mouth.

On the left side the colors are much darker and the lines are very obscure.

A fine line, lighter than the surrounding color, passes from each side of the blowhole to the stop.

The light color from the pectoral region passes forward underneath on the chin to a point in the median line $8\frac{1}{2}$ inches from the tip of the mandible. In advance of this the under side of the mandible is very dark yellowish gray, almost black. On the light-gray part of the throat are numerous small, elliptical, dark-gray spots, the largest of which are about three-eighths of an inch long. These can be seen also on the dark part of the mandible. The lower lips are yellowish white, like the upper, with scattered, small, quite black, spots

No. 112833, U.S.N.M., head, fins, and flukes.—The color is like that of No. 112832, but the markings are more distinct. A blackish cap on the head from the stop broadening out posteriorly. The margin on the right side is 3 inches above the eye. Below this margin on the right side over the eye

[a] The point where the convex outline of the forehead meets the base of the beak.

is a band of lighter gray extending down to 1½ inches above the eye. From this band down to the eye and forward to the stop the color is much lighter gray, which light color extends forward on to the base of the beak.

On the left side the only prominent light patch is at the base of the convexity of the head, about midway between the eye and stop. Under the chin the whitish color extends forward to 5½ inches of tip of mandible. As in the other specimen, a line extends from the stop to the right eye, broadening out posteriorly and inclosing it.

On the right side all the light color on the upper jaw from the eye forward, and all parts of the lower jaw backward to the base of the pectoral, are spotted with dark gray. The dark color of the anterior end of the mandible is made up of very small blackish spots massed together. These spots show also on the upper jaw, the upper lip being irregularly brownish-white and black-spotted.

Pectorals darker than surrounding areas except at base; darker above than below and spotted on both sides, but the spots most distinct on the under side. Dorsal blackish with very obscure small darker spots, especially on the right side, having an antero-posterior direction. Flukes very dark gray above, lighter below, very obscurely spotted with darker color. Margins apparently blackish.

The dimensions of the heads and fins are as follows:

Measurement.	No. 112832.	No. 112833.	Measurement.	No. 112832.	No. 112833.
	mm.	*mm.*		*mm.*	*mm.*
Tip of snout to stop (straight)	121	121	Transverse diameter of blowhole	24	22
Tip of snout to anterior point of blowhole (straight)	314	337	Pectoral, tip to head of humerus (straight)		286
Tip of snout to center of eye (straight)	330	337	Pectoral, tip to anterior insertion		279
Tip of snout to corner of mouth (straight)	283	289	Pectoral, tip to posterior insertion		216
Breadth of snout at stop (straight)	59	56	Pectoral, greatest breadth		86
Breadth of snout midway between stop and tip (straight)	43	43	Dorsal, height from center of base to tip		203
Vertical depth of snout (both jaws, with mouth closed) at stop (straight)	54	60	Dorsal, height from base of posterior margin to tip		168
Extent of lower jaw beyond the upper	6	6	Flukes, from tip to tip		464
Length of eye	22	19	Flukes, breadth at base		133
Antero-posterior diameter of blowhole	13	14	Flukes, depth of notch		25
			Number of teeth	44–43 42–40	42–43 39–40

The dimensions, in millimeters, of the two Hawaiian skulls, together with those of four other skulls of *Prodelphinus* from the Indian Ocean, collected by Dr. W. L. Abbott,[a] are as follows:

Measurement.	U.S.N.M. 112832, Hawaii.	U.S.N.M. 112833, Hawaii.	U.S.N.M. 36050 ♀, Amirantes Islands.	U.S.N.M. 36049 ♂, Amirantes Islands.	U.S.N.M. 36051 ♀, Providence Island.	U.S.N.M. 36031 ♀, Alphonse Island.	U.S.N.M. 36048 ♂, Johanna Island.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Total length	422	443	415	407	403	397	379
Length of beak	264	269	253	251	244	241	222
Breadth of beak at base of maxillary notches	97	92	95	95	91	96	90
Breadth of beak at its middle	48	46	42	43	41	43	40
Breadth of intermaxillæ at middle of beak	22	22	24	25	23	26	23
Greatest breadth between outer margins of intermaxillæ proximally	70	70	66	67	65	70	64
Length of superior tooth line	225	232	220	212	215	209	191
Last tooth to base of maxillary notch	45	45	44	45	38	42	37
Extremity of beak to anterior margin of superior nares	303	321	295	295	288	279	256
Breadth between orbits	159	164	158	156	156	156	146
Breadth between hind margins of temporal fossæ	125	130	122	127	122	123	117
Length of temporal fossæ	59	62	60	65	64	65	63
Depth of temporal fossæ	49	[b]50	47	56	53	56	54
Length of mandible	364	375	350	347	342	327	316
Length of symphysis of mandible	74	77	80	73	74	67	65
Length of tooth row of mandible	211	225	209	205	208	195	186
Depth between angle and coronoid process	59	57	57	63	59	62	53

[a] See Proc. U.S.Nat.Mus., 17, 1894, p. 33; paper No. 982.

[b] If measured on the continuation of the raised posterior border, = 51 mm; this is the right side. On the left, = 42 mm or 47 mm if measured on the continuation of the posterior raised border.

The number of valid species of the genus *Prodelphinus* is at present uncertain. In 1889, after an examination of the types of many of the nominal species and numerous other specimens belonging to the genus, I arrived at the conclusion that about eight species were probably distinct;[a] of these, the one to which the Hawaiian specimens should most probably be assigned is *Prodelphinus attenuatus* (Gray), of which *P. capensis* (Gray) is, I believe, a synonym.

A comparison of the dimensions of the type skulls of these two species with those of the Hawaiian skulls and Dr. Abbott's Indian Ocean specimens is given in the following table, the various dimensions being reduced to percentages of the total length.

Measurement.	Type of *P. capensis*.	Type of *P. attenuatus*.	U.S.N.M. 112832, Hawaii.	U.S.N.M. 112833, Hawaii.	U.S.N.M. 36050 ♀, Amirantes Islands.	U.S.N.M. 36049 ♂, Amirantes Islands.	U.S.N.M. 36051 ♀, Providence Island.	U.S.N.M. 36031 ♀, Alphonse Island.	U.S.N.M. 36048 ♂, Johanna Island.
Total length	*mm.* 413	*mm.* 383	*mm.* 422	*mm.* 443	*mm.* 415	*mm.* 407	*mm.* 403	*mm.* 397	*mm.* 379
	p. ct.	*p. ct.*	*p. ct.*	*p. ct.*	*p. ct.*	*p. ct.*	*p. ct.*	*p. ct.*	*p. ct.*
Length of beak	60.8	60	62.6	60.7	60.9	61.7	60.8	60.7	58.6
Breadth of beak at base of maxillary notches	22.8	22.7	22.9	20.8	22.9	23.3	22.6	24.2	23.8
Breadth of beak at its middle	10	10	11.4	10.4	10.1	10.6	10.2	10.8	10
Breadth of intermaxillæ at middle of beak	5.8	5.2	5.2	5	5.8	6.1	5.7	6.5	6.1
Greatest breadth between outer margins of intermaxillæ proximally	16.2	15.9	16.6	15.8	15.9	16.4	16.1	17.6	16.9
Length of superior tooth line	51.8	50.2	53.3	52.4	53	52.1	53.3	52.6	50.4
Last tooth to base of maxillary notch	10.4	11.2	10.7	10.2	10.6	11	9.4	10.6	9.7
Extremity of beak to anterior margin of superior nares	70.7	68.4	71.8	72.5	71.1	72.5	71.4	70.3	67.5
Breadth between orbits	39.7	38.4	37.7	37	38.1	38.3	38.7	39.3	38.5
Breadth between hind margins of temporal fossæ	28.8	30.8	30	29.4	29.4	31.2	30.3	31	30.9
Length of temporal fossæ	16.2	17	14	14	14.5	16	15.9	16.4	16.6
Depth of temporal fossæ	13.6	13.1	11.6	[a]11.3	11.3	13.2	13.2	14.1	14.2
Length of mandible	84.7	85.9	86.2	84.6	84.4	85.2	84.8	82.4	83.4
Length of symphysis of mandible	18.6	19.3	17.5	17.4	19.3	18	18.4	17	17.1
Length of tooth row of mandible	50	50.4	50	50.8	50.4	50.4	51.6	50	49.1
Depth between angle and coronoid process	13.8	13.8	14	12.9	13.4	15.5	14.6	15.6	14
Teeth	40-41 / 38-37	43-43 / 42-42	44-43 / 42-40	42-43 / 39-40	38-38 / 36-38	38-38 / 38-37	39-39 / 39-39	44-43 / 40-41	41-39 / 39-40

[a] 11.5 per cent if measured on continuation of raised posterior border; this is on the right side. On the left the depth is 9.5 per cent, or, if measured on continuation of posterior border, 10.6 per cent.

The correspondence of proportions in these several skulls is remarkable. Sir William H. Flower, no less than myself, was of the opinion that *P. attenuatus* and *P. capensis* are specifically identical. I have already advanced the view that Dr. Abbott's Indian Ocean specimens also belong to that species,[b] and would now assign the Hawaiian skulls to the same. It will be observed that in the Hawaiian skulls the temporal fossæ are smaller than in the type of *P. attenuatus* or that of *P. capensis*. This might be regarded as of some importance were it not that two skulls from off the Amirantes Islands (Nos. 36049 and 36050 U.S.N.M.), which there is every reason for believing belong to the same species, show an exactly parallel variation as compared with each other.

[a] Bull. U. S. Nat. Mus., 36, 1889, pp. 61–75, 162–166.

[b] Proc. U. S. Nat. Mus., 17, 1894, paper No. 982.

The Hawaiian skulls in one respect differ from all those from the Indian Ocean, namely, that the portion of the maxilla between the maxillary notch and the orbit is thinner. This and the somewhat larger size are the only two points in which these Hawaiian skulls appear to differ from the types of *P. attenuatus* and *P. capensis*. I do not think these are sufficient to warrant a separation of species.

As *P. attenuatus* is a species founded on cranial characters only, the coloration and external proportions of the Hawaiian heads, the size of the fins, and number of phalanges can not be brought into consideration in connection with it. It is of interest, however, to see how they compare with the same characters in Dr. Abbott's Indian Ocean specimens.

The coloration of the two Hawaiian heads is noted on a previous page. No doubt they were somewhat altered by post-mortem changes and the effects of the preservative when I examined them, but these would effect chiefly a deepening of the shades of gray. Beside the heads, I received, as already mentioned, a sketch of one of the specimens (Pl. 1) one-sixth natural size, but the sex was not recorded. It is dated June 7, 1901, and represents No. 112833 U.S.N.M.

In this sketch the specimen is represented as very dark gray, nearly black, on the upper surfaces, head, dorsal fin, upper surface of pectoral fin, upper and lower surfaces of flukes, posterior portion of caudal peduncle, and anterior half of mandible. The lower surfaces, from the middle of the mandible to within about 9 inches of the flukes, and as high up as the line of the insertion of the pectorals, are white, a little tinged with gray. The light and dark colors meet rather abruptly on the sides, but without a well-defined line of demarkation. The white of the lower surfaces is covered with oblong gray spots about three-fourths of an inch long. Similar spots are seen obscurely in the darker color higher up on the sides.

This sketch and the notes on page 44 indicate that the Hawaiian specimens resembled Dr. Abbott's Indian Ocean specimens very closely in coloration. In all of the latter, however, except one, the light and dark colors were said to be separated by a sharply-defined line. This is hardly true of the Hawaiian specimen represented by the water-color sketch, but on the other hand the colors can not be said to merge gradually into each other. If the hypothesis that males in this species have gray spots while females have white spots be accepted, the Hawaiian specimens should be males.

The following measurements of the Hawaiian specimen from which the sketch was made were taken when it was first obtained, June 7, 1901:

No. 112833, U.S.N.M., Honolulu, Hawaii, June 7, 1901.

	Inches.
Total length	76
Tip of snout to "stop"	5
Tip of snout to eye	13
Tip of snout to origin of pectoral	18
Tip of snout to origin of dorsal	35
Length of upper jaw	11.5
Length of lower jaw	11.63
"Gape"	11.5
Length of eye	1
Length of pectoral	11.5
Height of dorsal	11
Height of dorsal "straight up"	7

	Inches.
Length of base of dorsal	9
Least depth of caudal peduncle	.3
Expanse of flukes	18
"Length of flukes"	5.5
Distance from anus to notch of flukes	20
Distance from anus to "tip of flukes"	21
Distance between bases of pectorals in front	6.5
Greatest depth of body	14
Girth in front of pectorals	28.25
Girth immediately behind pectorals	30.5
Girth in front of dorsal	33

Dr. Abbott furnished a few measurements of his specimens.[a] These are most numerous in the case of No. 36049 U.S.N.M., male, from Amirantes Islands, and this specimen is fortunately almost the same size as the Hawaiian one of which the sketch was made. Measurements from the latter, compared with those recorded by Dr. Abbott, are as follows:

Measurement.	U.S.N.M. 36049, male, Amirantes Islands.	U.S.N.M. 112833, Hawaiian Islands.
	Inches.	*Inches.*
Total length	74	76
Tip of rostrum to base of dorsal fin	33	35
Height of dorsal fin	5.75	7
Breadth of flukes	17	18
Length of pectoral fin	10	11.5

This correspondence of external proportions tends to confirm the opinion derived from the cranial proportions, that Dr. Abbott's specimens and the Hawaiian ones belong to the same species.

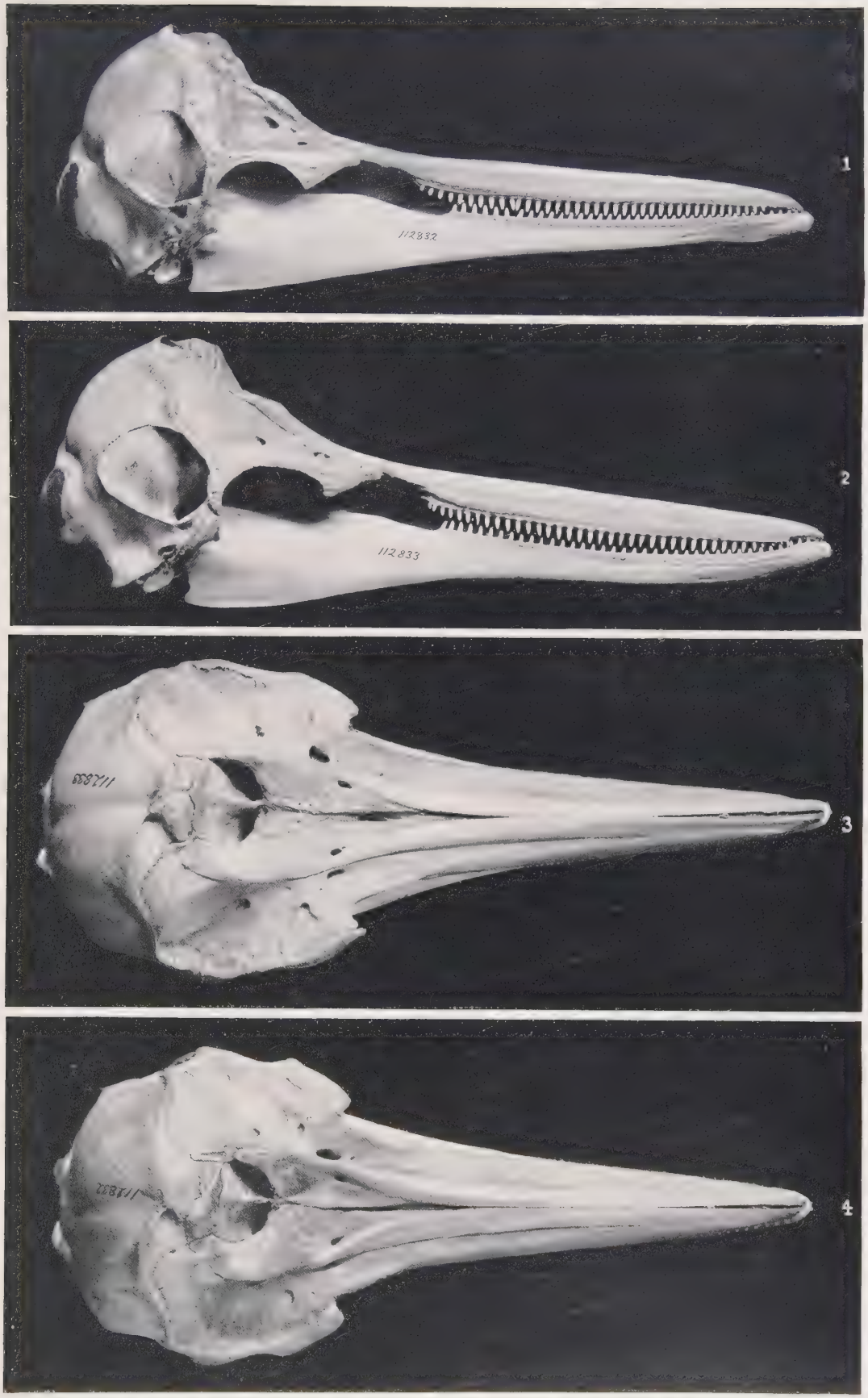
In one of Dr. Abbott's specimens, No. 36031 U.S.N.M., a female 6 feet 1 inch long, the girth at the anterior base of the dorsal fin was 38 inches. As the Honolulu specimen, which was 6 feet 4 inches long, had a girth of only 33 inches at this point, the opinion that it was a male is thereby strengthened, since the males are generally more slender than the females.

The phalanges in Hawaiian specimen No. 112833 and in three of Dr. Abbott's specimens are as follows:

Digits.	U.S.N.M. 36048, Johanna Islands.	U.S.N.M. 36049, Amirantes Islands.	U.S.N.M. 36051, Providence Islands.	U.S.N.M. 112833, Hawaiian Islands.
I	1	1	1	2
II	8	8	8	8
III	5	5	5	6
IV	2	2	2	2
V	1	0	1	1

The type of *P. capensis* (Gray), which I believe to be identical with *P. attenuatus* (Gray), was from the Cape of Good Hope. If the other specimens mentioned herein belong to that species also, as I believe they do, *P. attenuatus* would appear to range from the Cape of Good Hope through the Indian Ocean and across the South Pacific to Hawaii. The specimens described by Dr. Lütken in 1889,[b] which appear to belong to *P. attenuatus*, would extend the range of the species into the South Atlantic and as far north as a point about midway between St. Paul Islands and the Cape Verde Islands.

[a] Op. cit., p. 35. [b] Lütken, C. F. Vidensk. Selsk. Skr., 6 Raek., natur. Afd.; 5 Bd., 1, 1889, p. 45.



VIEWS OF TWO SKULLS OF PRODELPHINUS ATTENUATUS (GRAY), FROM HONOLULU, H. I.

1 and 4. No. 112832, U. S. Nat. Mus.
2 and 3. No. 112833, U. S. Nat. Mus. From the individual figured on Plate 1

ISOPODS COLLECTED AT THE HAWAIIAN ISLANDS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

By HARRIET RICHARDSON, Ph. D.

ISOPODS COLLECTED AT THE HAWAIIAN ISLANDS BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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The United States Fish Commission is undertaking a systematic exploration of the marine fauna of the Hawaiian Islands, under the direction of Dr. D. S. Jordan. During the summer of 1902, under the immediate charge of Prof. C. H. Gilbert, the *Albatross* was engaged in dredging in the vicinity, while a party of assistants explored the shore and shallow water.

The isopods collected were not numerous. Most of them are new to science, only two species in the collection, *Ligia hawaiensis* Dana and *Cymothoa recta* Dana, having been previously recorded from the islands.

Two new genera of parasitic isopods, representing different families of *Epicaridea*, the *Dajidæ* and the *Bopyridæ*, are herein described. The Bopyrid genus is particularly interesting, because it is the first of that family known to occur in the visceral cavity of Decapods, the *Entoniscidæ* alone being known to have that position in relation to their hosts, the Brachyurous Crustacea.

CHELIFERA or TANAIOIDEA.

Family APSEUDIDÆ.

Apseudes sp.?

One mutilated specimen was obtained by the United States Fish Commission steamer *Albatross* off the south coast of Molokai Island, the Hawaiian Islands.

FLABELLIFERA or CYMOTHOIDEA.

Family ÆGIDÆ.

Ægа quadratasinus Richardson sp. nov. Fig. 1.

Body (fig. 1 *a*) ovate, about 2⅓ times longer than broad. Color uniformly light yellow.

Head with frontal margin rounded and produced in a small median process between the basal joints of the first pair of antennæ; posterior margin nearly straight. Eyes situated on the anterolateral margin, extending along each side from the posterior margin of the head to the proximal end of the third peduncular joint of the first pair of antennæ and separated from each other on the anterior margin by a distance equal to the length of one eye. The first pair of antennæ (fig. 1 *b*) have the peduncle composed of 2 short joints of equal length and a long, slender joint equal to the length of the first two taken together; none of these joints are dilated; the flagellum is composed of 24 joints and extends to the posterior margin of the second thoracic segment. The second pair of antennæ have a 5-jointed peduncle, the distal end of the fifth joint of which extends to the middle of the first thoracic segment; the flagellum is composed of 24 joints and reaches the posterior margin of the third thoracic segment. The frontal lamina or interantennal plate is cone-shaped. round and flat at its distal end, and produced at its proximal end to an acute point.

The segments of the thorax are equal in length. The epimera of the second, third, and fourth segments are not produced posteriorly beyond the margin of the segment; those of the fifth, sixth, and seventh segments are produced backward.

There is an arcuate carina on all the epimera which extends from the post-lateral external angle to the internal antero-lateral angle of the opposite side.

All 6 segments of abdomen distinct, the first segment a little shorter than the 4 following. The sixth or terminal segment is well rounded posteriorly, with a pronounced and wide emargination, quadrangular in shape, in the median line. On either side of this emargination the posterior margin is crenulate for some distance and provided with minute spines, about 8 on either side.

The uropoda (fig. 1 *c*) are about equal in length and are not longer than the terminal abdominal segment. The outer branch is oval in shape, denticulate, and provided with spines on the external and posterior margin. The inner branch is unlike the outer branch in shape, and tapers to a narrow extremity at the post-lateral side of the external margin, the external margin being almost straight; this branch is more distinctly crenulate on the lower part of the external margin and provided with small spines.

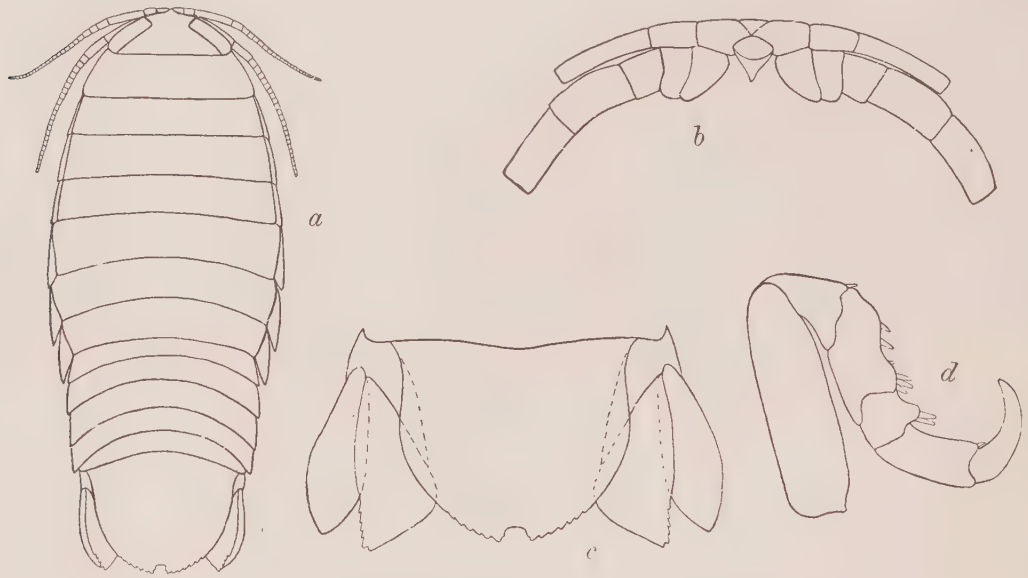

FIG. 1.—*Æga quadratasinus.* (*a*) General figure, × 4; (*b*) Frontal lamina and peduncles of both pairs of antennæ, × 7; (*c*) Terminal segment and uropoda, × 8; (*d*) Leg of 3d pair, × 8.

The first three pairs of legs are prehensile. On the third pair (fig. 1 *d*) there is 1 spine on the ischium, 6 on the merus, 2 on the carpus, and 1 at the distal end of the propodus. The 4 following pairs of legs are gressorial, and are provided with spines on the ischium, merus, carpus, and propodus.

Only one specimen was obtained in 1902 from Kauai Island, the Hawaiian Islands, by the United States Fish Commission steamer *Albatross*.

Type in United States National Museum. Cat. No. 28971.

This species approximates more closely to *Æga incisa*[a] Schiœdte & Meinert than to any other described species of the genus. It differs, however, in the shape of the abdomen, which is more triangular in *A. incisa;* in the shape of the terminal notch, which is V-shaped in *A. incisa*, more quadrangular in *A. quadratasinus;* in the smaller eyes, which do not meet in the median line as in *A. incisa* but are separated by a space equal to the length of one eye; by the longer antennæ of both pairs, each containing also a greater number of joints in the flagellum; and in having the prehensile legs provided with numerous spines, while in *A. incisa* there is a single spine on the ischium and a single one on the carpus.

[a] Naturhistorisk Tidsskrift (3), XII, 1879–1880, pp. 373–374, pl. X, figs. 13–15.

Ægа deshayesiana Milne Edwards.

Rocinela deshayesiana Milne Edwards, Hist. Nat. Crust., III, p. 243.
Ægа deshayesiana Schiœdte & Meinert, Naturhistorisk Tidsskrift, XII (3), 1879–1880, pp. 360–361, pl. VIII, figs. 7–9.

Locality.—Pailolo Channel, between Molokai and Maui Islands and Northeast Approach.

This species is recorded from the Mediterranean (Milne Edwards); from the Adriatic, at Fayal, the Azores, and Panorma (Schiœdte & Meinert); from lat. 15° 40′ N., long. 23° 5′ 8″ W. (Studer).

A single specimen was obtained by the *Albatross* which differs from those recorded as described and figured by Schiœdte & Meinert only in having 7 spines instead of 6 on the merus, and in not having the single spine on the distal end of the propodus. Its occurrence in this locality is rather remarkable.

Rocinela hawaiiensis Richardson, sp. nov. Fig. 2.

Body (fig. 2 *a*) narrow, elongate, 2½ times longer than wide. Color uniformly yellow, with no markings.

Head triangular; front produced over the basal joints of the first pair of antennæ. Eyes very large and round, separated from each other by a distance equal only to half the width of one eye. First pair of antennæ, with a flagellum of 5 joints, extend to the end of the peduncle of the second pair of antennæ. Second pair of antennæ, with a flagellum of 17 joints, reach the posterior margin of the second thoracic segment.

First two segments of thorax subequal in length; third and fourth subequal and a little longer than the first two; fifth and sixth longest, each one nearly equal to the first two segments taken together; seventh segment shorter than the two preceding, about equal to the third or fourth. Epimera of the last four segments acutely pointed at their posterior extremities; those of the second and third segments more rounded posteriorly.

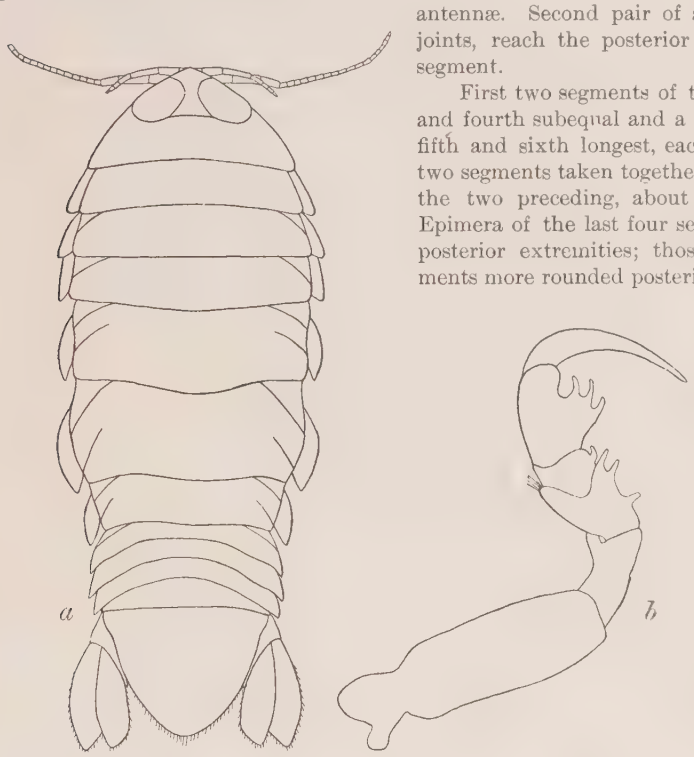

FIG. 2.—*Rocinela hawaiiensis.* (*a*) General figure, ×4; (*b*) Leg of second pair, ×8

The first abdominal segment is entirely concealed by the seventh thoracic segment except at the sides; the three following segments are subequal, with acutely produced postero-lateral angles; the fourth segment has the sides not produced and mostly covered by the postero-lateral angles of the preceding segment; terminal segment narrowly rounded. Uropoda oar-like, subequal in length and equal in width. Both branches are faintly crenulate on the external margin. The basal joint of the uropoda extends only half the length of the inner branch.

First 3 pairs of legs (fig. 2 *b*) prehensile, with long, slender, curved dactyli; propodus armed with 3 spines; the carpus with 1 spine, and the merus with 3 spines, except on the first pair of legs. The 4 gressorial legs are long and slender and armed with few spines.

Only one specimen was taken by the U. S. Fish Commission steamer *Albatross* at Kauai Island, the Hawaiian Islands, at a depth of 636 to 414 fathoms.

Type in U. S. National Museum. Cat. No. 28972.

This species is perhaps nearer to *R. orientalis* Schiœdte & Meinert[a] than to any other known species of the genus. It differs from that form, however, in the much larger eyes which are separated

[a] Naturhistorisk Tidsskrift, (3), XII, 1879–80.

by a distance equal only to half the width of one eye, while in *R. orientalis* the eyes are separated by a distance equal to one-third the width of the head; in the narrower and more elongate body; in having the two branches of the uropoda of equal length and width, while in *R. orientalis* the outer branch is narrower and shorter than the inner branch; in the shorter basal joint of the uropoda, it being equal to half the length of the inner branch, while in *R. orientalis* the basal joint extends almost to the posterior extremity of the inner branch; and in the narrower terminal abdominal segment.

Family CYMOTHOIDÆ.

Cymothoa recta Dana.

Cymothoa recta Dana, U. S. Expl. Exp. Crustacea, XIV, pp. 751–752, pl. XLIX, fig. 13 *a–c*.

Locality: Puako Bay, Hawaii.

Dana's specimens were obtained at Hilo, Hawaii, by Dr. C. Pickering.

Only one adult specimen was obtained, but a large number of young males (fig. 3), which are probably the young of this species, were taken from the following localities: Between Kauai Island and Modu Maru or Bird Island; north coast of Molokai Island; south coast of Oahu Island. Depth, 6½ to 299 fathoms. These young specimens are probably at a stage somewhat later than the young of the first and second stages described by Schiœdte & Meinert[a] for *C. œstrum* Linn. and *C. eximia*, because all seven pairs of legs are present. The pleopods, uropods, and terminal segment are, however, fringed with hairs, and the first and second antennæ are very long, the first pair reaching the extremity of the first thoracic segment and composed each of ten joints, the second pair extending to the posterior margin of the third thoracic segment and composed each of 16 long joints. The eyes are large and post-laterally situated, and the frontal margin of the head is well rounded. The antero-lateral angles of the first thoracic segment are not produced along the sides of the head as in the adult.

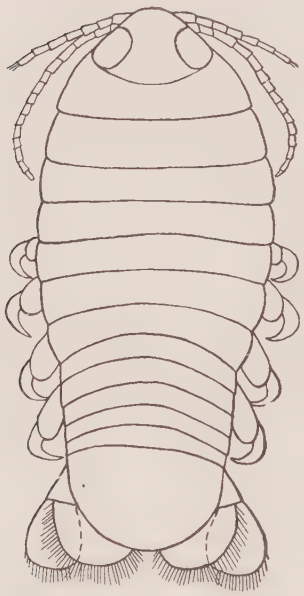

FIG. 3.—Young male of *Cymothoa recta*, × 12.

ONISCOIDEA.

Family LIGIIDÆ.

Ligia hawaiensis Dana.

Lygia hawaiensis, Dana, U. S. Expl. Exp., Crustacea, part 2, vol. XIV, pp. 740–741, pl. XLIX, fig. 4 *a–e*.

Locality: Pearl Harbor.

A single specimen, without uropods, is referred to the above species described by Dana from the islands Oahu and Kauai in the Hawaiian Archipelago. The specimen differs from the description in having shorter antennæ, which do not extend beyond the fifth thoracic segment. Difference in sex may account for this, as it has been shown that in this genus the antennæ of the females are shorter than those of the males.

Family ONISCIDÆ.

Porcellio lævis Latreille.

Porcellio lævis Latreille, Hist. Crust. Ins., VII, p. 46. Leach, Edinb. Encycl., VII, p. 406. Milne-Edwards, Hist. Nat. des Crust., III, p. 169. Budde-Lund, Nat. Tidsskrift, (3) VII, p. 236; Crust. Isop. Terrestria, 1885, pp. 138–141. (See Budde-Lund for further synonymy.)

Locality: Aiea, Oahu.

[a] Naturhistorisk Tidsskrift, (3), XIV, 1883–84, pp. 276–278 and 281–282, pl. VIII, fig. 10–13, pl. IX, fig. 11.

EPICARIDEA or BOPYROIDEA.

Family DAJIDÆ.

ZONOPHRYXUS Richardson, gen. nov.

Type, *Zonophryxus retrodens* Richardson, sp. nov.

Body of female provided on the ventral side with a border which surrounds it on all sides, and which is wider in the anterior or cephalic region. The posterior portion of this marginal border is provided with nine small triangular processes, four on either side of the median one, and undoubtedly indicates five coalesced abdominal segments. Five pairs of legs are present on the anterior half of the ventral side. Five pairs of incubatory lamellæ on either side of the ventral surface meet in the median line, the fifth pair being narrow and elongate and concealing the second and third pairs, which are very small, and a part of the fourth pair. Dorsal surface convex, with only faint traces of segmentation, the boundaries of the three divisions of the body not being indicated. Small incisions at the side of

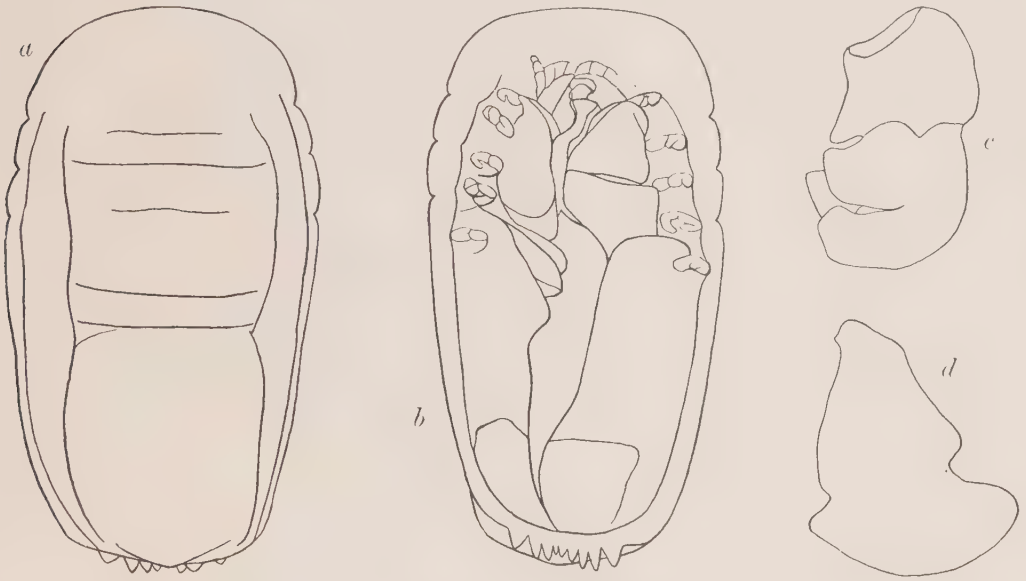

FIG. 4.—*Zonophryxus retrodens*. (*a*) Dorsal view, × 6.6; (*b*) Ventral view, × 6.6; (*c*) Maxilliped, × 9.33; (*d*) First lamella of marsupium (right side), × 9.33.

the anterior half of the body on the marginal border probably indicate the place of separation of the head from the thorax, the first thoracic segment from the second, and the second from the third.

Male with the first thoracic segment fused with the head. All 7 pairs of legs present. Segments of abdomen consolidated into one.

This genus differs from all the other *Dajidæ* in having a marginal border surrounding the body and in having nine triangular processes on the posterior margin of this border, representing 5 coalesced abdominal segments.

It differs from *Dajus* Kroyer in having the segments of the abdomen fused in the female; in having but slight traces of segmentation in the thoracic region, and in both male and female lacking uropoda. It differs from *Branchiophryxus* Caullery in having 5 pairs of legs and 5 pairs of incubatory lamellæ, only 4 pairs of legs and of incubatory lamellæ being true of *Branchiophryxus*, and in having a single pair of pleopoda, which are altogether wanting in that genus. It differs from *Notophryxus* Sars in the form of the abdomen and head, and in having 5 pairs of incubatory lamellæ instead of a single pair. It differs from *Aspidophryxus* Sars in the form of the head and abdomen of the female, and in having no trace of segmentation or appendages to the abdomen of the male.

Zonophryxus retrodens Richardson, sp. nov.

Body of female (fig. 4 *a*, *b*) rather quadrangular in shape, with only faint traces of segmentation on the dorsal surface. Dorsal surface very convex, with no distinct boundary between the three chief divisions of the body, the head, thorax, and abdomen being continuously one. On the ventral side a border surrounds the entire body, and is wider in the cephalic region.

The cephalic part projects in front as a broadly rounded area or border. On either side of the body on the anterior half, the lateral border is incised with three small indentations, marking off the head from the first thoracic segment, the second from the first, and the third from the second. Five indistinct lines on the dorsal surface of the anterior half of the body mark off the head from the thorax and outline the first four thoracic segments. The posterior half of the body shows no trace of segmentation on the dorsal surface. The posterior margin of the border at the terminal part of the body is produced in 9 triangularly-shaped processes. These processes are arranged four on either side of a median one, and undoubtedly indicate the 5 coalesced abdominal segments.

The legs are in 5 pairs and are confined to the anterior half of the body on the ventral side.

The incubatory lamellæ (fig. 4 *d*) consist of 5 pairs of plates, meeting in the median ventral line. The fifth pair overlap the second, third, and fourth pairs.

Only a single pair of pleopoda are present, which fold back upon the lower portion of the fifth pair of incubatory plates.

From the oral area there extends on the ventral side a long process, which subdivides and terminates in two lobes, one on either side, beneath the incubatory lamellæ.

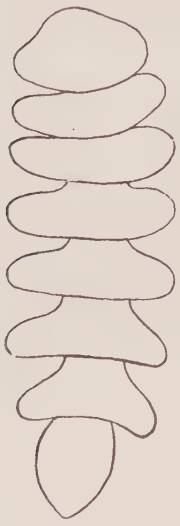

FIG. 5.—*Zonophryxus retrodens*. Male, × 13.3.

The male (fig. 5) has the head fused with the first thoracic segment. The other 6 segments are free and distinct. All the segments of the abdomen are consolidated into one, which is somewhat oval and pointed posteriorly. All 7 pairs of legs are present, the first pair being attached to the cephalic segment. Head large, concave on its dorsal surface, the anterior margin produced into a rounded process, which is directed upward. Eyes wanting. No pleopoda or uropoda.

Only one specimen was obtained by the U. S. Fish Commission steamer *Albatross* from the south coast of Oahu Island, Hawaiian Islands, in 1902. The specimen was unattached.

Type in U. S. National Museum. Cat. No. 28970.

Family BOPYRIDÆ.

Subfamily ENTOPHILINÆ.

ENTOPHILUS Richardson, gen. nov.

Type, *Entophilus omnitectus* Richardson, sp. nov.

Body of female rather asymmetrical. Dorsal surface with segmentation indicated by depressions more or less clearly defined. All 7 pairs of legs present. Marsupium bounded ventrally by 5 pairs of incubatory lamellæ. Seven pairs of plates, overlapping the dorsal surface and attached only to the bases of the legs, extend in two longitudinal series, one on either side of the thorax; these plates probably correspond to the epimeral plates.

Two series of 5 plates each are present on either side of the abdomen, meeting along the median dorsal side and surrounding the abdomen at the sides, the lower plates nearly meeting again on the ventral side in the median line. Terminal part of abdomen truncate.

Pleopoda consisting of 5 pairs of double-branched lamellæ. Uropoda absent.

Male with the 6 segments of the abdomen clearly and distinctly defined, the last segment provided with a pair of single-branched uropoda; all the preceding segments of the abdomen provided with a pair of single-branched, well-developed pleopoda. Seven pairs of thoracic legs attached to the 7 thoracic segments.

Entophilus omnitectus Richardson, sp. nov. Fig. 6.

Body of female somewhat asymmetrical. Segmentation on dorsal surface more or less indistinctly defined. Marsupial pouch on ventral side extremely large and completely enclosed by incubatory lamellæ, which are visible from a dorsal view at the sides of the body.

Color of dorsal surface of thorax, orange; head, abdomen, and incubatory plates, white. The orange markings on the young within the marsupium give an orange appearance to the ventral side of the body.

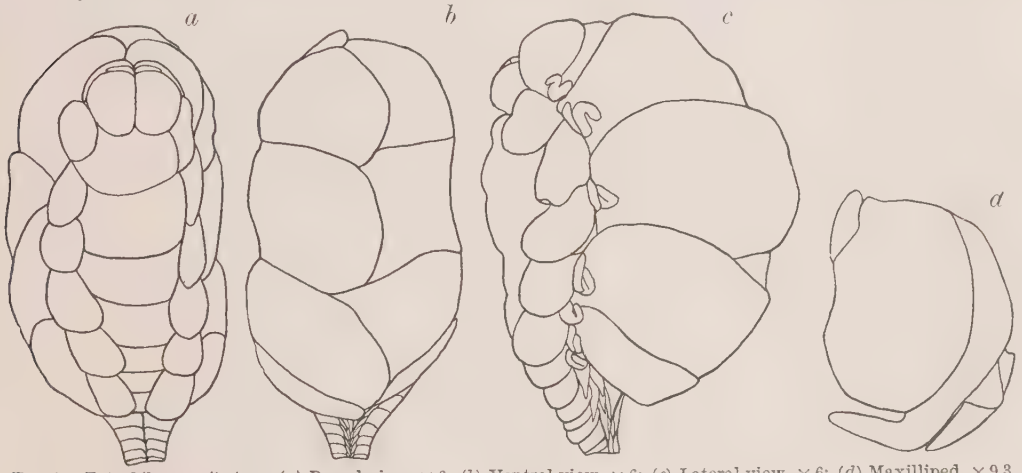

FIG. 6.—*Entophilus omnitectus.* (*a*) Dorsal view, × 6; (*b*) Ventral view, × 6; (*c*) Lateral view, × 6; (*d*) Maxilliped, × 9.3.

Head distinctly bilobed. Eyes absent. Both pairs of antennæ visible from a dorsal view, the first pair consisting of perhaps three indistinct joints. The second pair extend half the length of the head and consist of a number of indistinctly defined joints.

The segments of the thorax are more distinctly defined in some specimens than in others. Along the lateral margins of the thorax is a series of plates, a pair for each segment. These plates overlap

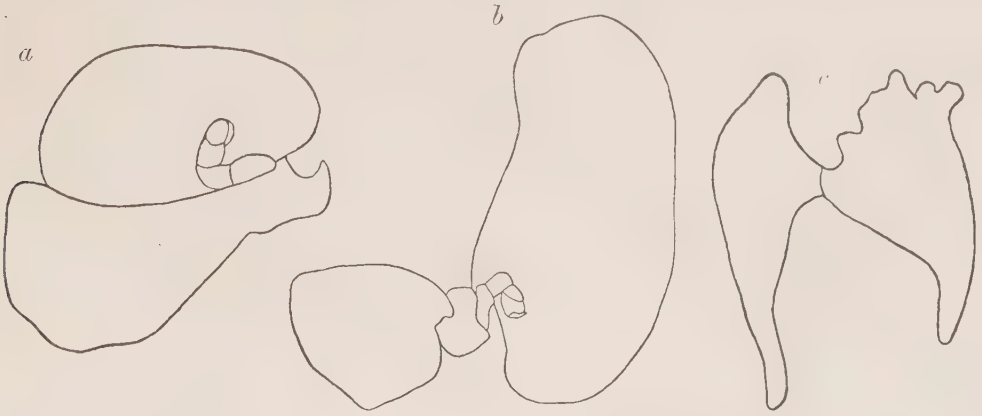

FIG. 7.—*Entophilus omnitectus.* (*a*) First lamella of marsupium, × 9.3; (*b*) Leg of 5th pair with 5th lamella of marsupium attached (on right side) and 5th "lame pleurale," × 7; (*c*) One double-branched pleopod, × 26.

the dorsal surface of the thorax at the sides and are free on their whole surface, being atttached only at the extreme lateral margin to the legs.

Similar plates are also found on the abdomen, where they meet five from either side along the median dorsal line. The exact homology of these plates is rather doubtful, but it seems probable that they correspond to the "lames pleurales" of Giard and Bonnier.

The 5 pairs of abdominal plates, which meet in the median line on the dorsal side, extend around the sides of the abdomen and gradually almost come together on the ventral side, the last pair being very much closer together than the first pair. The last two pairs of plates are almost concealed by the overlapping plates of the preceding segments.

The extremity of the abdomen is truncate and without uropoda. The pleopoda (fig. 7 *c*) are 5 pairs of double-branched tapering appendages, all similar in shape.

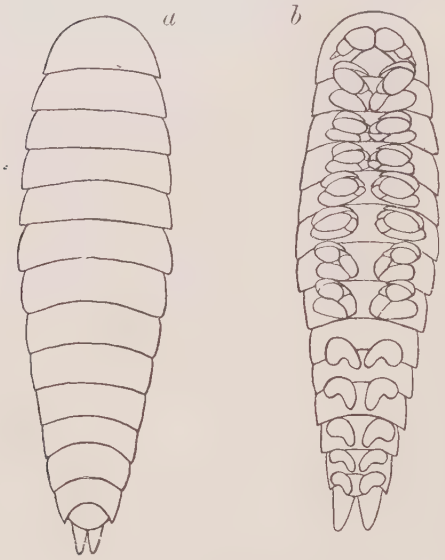

FIG. 8.—*Entophilus omnitectus*. Male. (*a*) Dorsal view, × 11.3; (*b*) Ventral view, × 11.3.

There are 5 pairs of incubatory lamellæ, which form the ventral side of the marsupial pouch, enclosing it completely, the lamellæ overlapping in the median line.

Seven pairs of small, feeble legs are present, a pair or each segment of the thorax.

The male (fig. 8) is narrow and elongate and without any color markings. The head is very large and without eyes. The 7 segments of the thorax are about equal in length, each one carrying a pair of appendages, so that there are 7 pairs of thoracic legs in all. The 6 segments of the abdomen are distinct, the terminal one being rounded and carrying a pair of single-branched appendages, the uropoda; the 5 preceding abdominal segments are provided each with a pair of single-branched, well-developed pleopoda.

A large number of specimens were obtained by the U. S. Fish Commission steamer *Albatross* on the north and northeast coast of Main Island, Hawaiian Islands, and the northeast approach to Pailolo Channel, between Main Island and Molokai Island.

The parasites were found in the visceral cavity of *Munnida normani* Henderson. This is the first instance of the discovery of a Bopyrid in that position in relation to its host, all the other known representatives of the family being either branchial or abdominal parasites. The *Entoniscidæ*, on the other hand, are always found in the visceral cavity.

Type in the U. S. National Museum. Cat. No. 28967.

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THE BRACHYURA AND MACRURA OF THE HAWAIIAN ISLANDS.

By MARY J. RATHBUN.

NATIVE HAWAIIAN BOY CATCHING CRABS.

From photograph by H. W. Henshaw.

THE BRACHYURA AND MACRURA OF THE HAWAIIAN ISLANDS.

By MARY J. RATHBUN.

Relatively little has been published hitherto on the decapod fauna of the Hawaiian Islands, the collecting done by the earlier expeditions being limited usually to a few days. The number of species and subspecies of Brachyura and Macrura known up to the present time was 109; in this paper that number is increased to 314.[a] Of these the majority (245 species) have been obtained by the U. S. Fish Commission. A few derived from other sources are contained in the National Museum collection, and 26 have been added by examination of the Brachyura in the Museum of Comparative Zoology, a privilege granted to the author by Dr. Walter Faxon, who had previously made the determinations. Twenty-eight other species are attributed to the islands in various publications, but the present writer had no means of verifying these records.[b]

The Fish Commission explorations began in 1891, in connection with the cable survey between California and the Hawaiian Islands, when ten hauls of the trawl and tangles were made, mostly between 300 and 375 fathoms. The results were meager compared with those realized by the three months' systematic exploration by a land party in 1901 under the leadership of Dr. D. S. Jordan and Dr. B. W. Evermann and by the *Albatross* in 1902.[c] This vessel occupied 397 stations in the vicinity of the islands, while field parties, led by Dr. Charles H. Gilbert, explored the shores and reefs as well as the fresh-water streams. Mr. Walter K. Fisher, of Stanford University, has given added value to the specimens by notes on their habits, color, etc.

Mr. Henry W. Henshaw, for many years a resident of Hilo, has from time to time sent Crustacea to the National Museum, and has added several species to this list. Other contributors are the late Valdemar Knudsen, a wealthy planter of the island of Kauai who was much interested in natural history, and Mr. R. C. McGregor, of the U. S. Coast and Geodetic Survey.

The Hawaiian crabs at the Museum of Comparative Zoology were taken nearly half a century ago by Mr. Andrew Garrett and Mr. Horace Mann, both zealous

[a] The Hawaiian Crangonidæ (=Alpheidæ) have been assigned to Dr. H. Coutière, of the École Supérieure de Pharmacie, Paris; the Anomura to Dr. James E. Benedict, of the U. S. National Museum.

[b] Some of these species have not since been collected, or are known only from description and figure, the type specimen having been destroyed, as *Galene hawaiiensis* Dana. A few species it is almost certain have been erroneously recorded from the Hawaiian Islands, as *Trichodactylus punctatus* Eydoux and Souleyet, which is a South American fluviatile crab, and *Pachygrapsus crassipes* Randall, one of several forms collected by Nuttall and Townsend and confused with others taken on the California coast. The occurrence of *Ocypode gaudichaudii* at Honolulu needs confirmation.

[c] A single dredging often embraced a long period of time and a great range of depth, therefore the statement that a species was taken at 68–179 fathoms does not indicate its actual range, but simply its occurrence at some point between those depths.

collectors, or later by Dr. W. H. Jones, U. S. Navy, who, with Dr. T. H. Streets, was surgeon and naturalist on the U. S. S. *Portsmouth* during the survey of the North Pacific Ocean in 1873–74.

Through the courtesy of Mr. Witmer Stone, the writer has made an examination of all of Randall's types of Hawaiian crabs and shrimps extant in the museum of the Philadelphia Academy of Natural Sciences. Some of these have been noted by Kingsley, Sharp, and Ortmann, but the validity of *Penæus marginatus* Randall is here established for the first time.

The Hawaiian fauna is almost entirely Indo-Pacific, the islands forming the northeastern, as the Indian Ocean is the southwestern limit, for the majority of the species. This is true of the shore and shallow water forms[a] and in a lesser degree of the abyssal forms, of which many are cosmopolitan and have been described by Smith, Bate, A. Milne Edwards, or Alcock, from the depths of the Atlantic, Pacific, or Indian oceans.[b] This circumstance of wide horizontal distribution of deep-water species has recently been emphasized by Ortmann in reporting on the Schizopoda."[c]

Besides 76 of the 80 species here described as new, few species are restricted to the Hawaiian Islands, and such apparent restriction may be due to incomplete knowledge. Very little affinity to the fauna of the American continent is shown. *Micropanope sexlobata*, a new species, forms a marked exception, as the genus is tropical American and the Hawaiian species is akin to *M. truncatifrons* Rathbun of the West Indies.

The figures of *Cyrtomaia smithi* were drawn by the late Dr. J. C. McConnell; the other drawings of Brachyura, as well as all the colored plates, are the work of Mr. A. H. Baldwin; Miss E. G. Mitchell made the pen and ink drawings of most of the Macrura. The photographs were taken by Mr. Clarence Dodge, excepting Plates I and II, which are the gift of Mr. H. W. Henshaw.

LIST OF THE SPECIES.[d]

Ocypode ceratophthalma (Pallas).
Ocypode lævis Dana.
? Ocypode gaudichaudii Milne Edwards and Lucas.
Uca minor (Owen).
Uca tetragonon (Herbst).
Macrophthalmus telescopicus (Owen).
Macrophthalmus inermis A. Milne Edwards.
Libystes nitidus A. Milne Edwards.
Pilumnoplax cooki Rathbun, nov.
Palicus fisheri Rathbun, nov.
Palicus oahuensis Rathbun, nov.
Manella spinipes (de Man), gen. nov.
Cardisoma rotundum (Quoy and Gaimard).
*Grapsus grapsus tenuicrustatus (Herbst).
Grapsus strigosus (Herbst).
Grapsus strigosus longitarsis Dana.
Geograpsus lividus (Milne Edwards).
Geograpsus crinipes (Dana).
Hemigrapsus crassimanus Dana.
Metopograpsus messor (Forskål).
Pachygrapsus plicatus (Milne Edwards).
Pachygrapsus minutus A. Milne Edwards.
Pachygrapsus longipes Rathbun.
? Pachygrapsus crassipes Randall.
Planes minutus (Linnæus).
Cyclograpsus granulatus Dana.
Cyclograpsus henshawi Rathbun.
Cyclograpsus cinereus Dana.
Sesarma (Sesarma) angustifrons A. Milne Edwards.
Sesarma (Holometopus) obtusifrons Dana.

[a] The synonymy is abbreviated in the case of well-known Indian species to a reference to Alcock's classical work on the Carcinological Fauna of India, the first part of which appeared in 1895 (Jour. Asiat. Soc. Bengal, LXIV), and in which full references and descriptions may be found.

[b] The following shrimps occur in greatest abundance: *Pandalus martius* A. Milne Edwards, *Heterocarpus ensifer* A. Milne Edwards, *Polycheles phosphorus* (Alcock), *Nematocarcinus tenuirostris* Bate, and *Pandalus ensis* (A. Milne Edwards).

[c] Science, n. s., XIX, 1904, No. 491, pp. 827–828.

[d] Those marked with an asterisk were found in the market at Honolulu.

Sesarma (Holometopus) trapezium Dana.
Sarmatium faxoni Rathbun, nov.
Plagusia depressa tuberculata Lamarck.
Plagusia immaculata Lamarck.
Percnon planissimum (Herbst).
Percnon abbreviatum (Dana).
Percnon pilimanus (A. Milne Edwards).
?Trichodactylus punctatus Eydoux and Souleyet.
*Carpilius maculatus (Linnæus).
*Carpilius convexus (Forskål).
Carpilodes tristis Dana.
Carpilodes ruber A. Milne Edwards.
Carpilodes coccineus Rathbun, nov.
Carpilodes virgatus Rathbun, nov.
Carpilodes vaillantianus (A. Milne Edwards).
Carpilodes monticulosus A. Milne Edwards.
Carpilodes supernodosus Rathbun, nov.
Liomera pubescens (Milne Edwards).
Liomera prætexta Rathbun, nov.
Atergatis ocyroe (Herbst).
Platypodia semigranosa (Heller).
Platypodia granulosa (Rüppell).
Platypodia eydouxii (A. Milne Edwards).
Platypodia actæoides (A. Milne Edwards).
Zosimus æneus (Linnæus).
Lophozozymus incisus (Milne Edwards).
Lophozozymus dodone (Herbst).
Lophozozymus intonsus (Randall).
Xantho lacunosus Rathbun, nov.
Xantho bidentatus A. Milne Edwards.
Xantho crassimanus A. Milne Edwards.
Leptodius exaratus (Milne Edwards).
Leptodius sanguineus (Milne Edwards).
Leptodius molokaiensis Rathbun, nov.
Leptodius nudipes (Dana).
Leptodius gracilis (Dana).
Leptodius waialuanus Rathbun, nov.
Xanthodius biunguis Rathbun, nov.
Medæus ornatus Dana.
Medæus simplex A. Milne Edwards.
Cycloxanthops angustus Rathbun, nov.
Pelœus armatus Eydoux and Souleyet.
Etisus dentatus (Herbst).
*Etisus splendidus Rathbun, nov.
*Etisus lævimanus Randall.
Etisodes electra (Herbst).
Galene hawaiiensis Dana.
Actæa tomentosa (Milne Edwards).
Actæa affinis (Dana).
Actæa hirsutissima (Rüppell).
Actæa rufopunctata (Milne Edwards).
Actæa garretti Rathbun, nov.
Actæa speciosa (Dana).
Actæa variolosa Borradaile.
Actæa nodulosa White.
Actæa hawaiiensis Rathbun, nov.
Actæa (?) integerrima (Dana).
Banareia villosa Rathbun, nov.
Daira perlata (Herbst).
Xanthias lamarckii (Milne Edwards).
Xanthias flavescens Rathbun, nov.
Xanthias notatus (Dana).
Xanthias minutus (Rathbun).
Xanthias canaliculatus Rathbun, nov.
Micropanope sexlobata Rathbun, nov.
Chlorodiella niger (Forskål).
Chlorodiella lævissima (Dana).
Phymodius ungulatus (Milne Edwards).
Phymodius obscurus (Lucas).
Phymodius nitidus (Dana).
Phymodius laysani Rathbun, nov.
Chlorodopsis areolata (Milne Edwards).
Chlorodopsis scabricula (Dana).
Chlorodopsis aberrans Rathbun, nov.
Pilodius flavus Rathbun.
Menippe convexa Rathbun.
Pseudozius caystrus (Adams and White).
Pseudozius inornatus Dana.
Pseudozius triunguiculatus Borradaile.
Platyozius lævis Borradaile.
Ozius hawaiiensis Rathbun.
Lydia annulipes (Milne Edwards).
Pilumnus vespertilio (Fabricius).
Pilumnus alcocki Borradaile.
Pilumnus nuttingi Rathbun, nov.
Pilumnus acutifrons Rathbun, nov.
Pilumnus andersoni de Man.
Pilumnus tæniola Rathbun, nov.
Pilumnus ovalis A. Milne Edwards.
Actumnus obesus Dana.
Eriphia sebana (Shaw).
Grapsillus cymodoce (Herbst).
Grapsillus ferrugineus (Latreille).
Grapsillus ferrugineus intermedius (Miers).
Grapsillus maculatus MacLeay.
Grapsillus rufopunctatus (Herbst).
Grapsillus rufopunctatus flavopunctatus (Eydoux and Souleyet).
Grapsillus digitalis (Latreille).
Domecia hispida Eydoux and Souleyet.
Lybia tesselata (Latreille).
Lybia cæstifera (Alcock).
Polydectus cupulifer (Latreille).
Carcinides mænas (Linnæus).
Parathranites hexagonum Rathbun, nov.
Parathranites latibrachium Rathbun, nov.
Lissocarcinus orbicularis Dana.
Lissocarcinus lævis Miers.
Lupocyclus quinquedentatus Rathbun, nov.
Goniocaphyra inæqualis Rathbun, nov.

Carupa læviuscula Heller.
Portunus sanguinolentus (Herbst).
*Portunus pubescens (Dana).
Portunus (Achelous) argentatus (A. Milne Edwards).
Portunus (Achelous) granulatus (A. Milne Edwards.
Portunus (Achelous) orbicularis (Richters).
Portunus (Xiphonectes) longispinosus (Dana).
Portunus (Xiphonectes) macrophthalmus Rathbun, nov.
Charybdis japonica (A. Milne Edwards).
*Charybdis erythrodactyla (Lamarck).
Charybdis orientalis Dana.
Thalamonyx gracilipes A. Milne Edwards.
Thalamita cœruleipes Jacquinot.
Thalamita picta Stimpson.
Thalamita sima Milne Edwards.
*Thalamita integra Dana.
Thalamita edwardsi Borradaile.
Thalamita admete (Herbst).
Thalamita auauensis Rathbun, nov.
Thalamita spinifera Borradaile.
Thalamita alcocki de Man.
Thalamita kukenthali de Man.
Podophthalmus vigil (Fabricius).
Kraussia integra (de Haan).
Kraussia rugulosa (Krauss).
Kraussia hendersoni Rathbun.
Platepistoma macrophthalmum Rathbun, gen. et sp. nov.
Achæus affinis Miers.
Achæopsis superciliaris Ortmann.
Cyrtomaia smithi Rathbun.
Cyrtomaia lamellata Rathbun, nov.
Oncinopus aranea (de Haan).
Sphenocarcinus carbunculus Rathbun, nov.
Huenia proteus (de Haan).
Simocarcinus simplex (Dana).
Echinœcus pentagonus Rathbun.
Menæthius monoceros (Latreille).
Acanthonyx simplex Dana.
Halimus hilgendorfi (de Man).
Halimus tenuicornis (Pocock).
Halimus ovatus (Dana).
Perinea tumida Dana.
Chlorinoides goldsboroughi Rathbun, nov.
Schizophrys hilensis Rathbun, nov.
Ophthalmias cervicornis (Herbst).
Micippa philyra (Herbst).
Micippa parca Alcock.
Parthenope (Platylambrus) nummifera Rathbun, nov.
Parthenope (Platylambrus) stellata Rathbun, nov.
Parthenope (Platylambrus) stellata lacunosa Rathbun, subsp. nov.
Parthenope (Platylambrus) stellata complanata Rathbun, subsp. nov.
Parthenope (Rhinolambrus) lamelligera (White).
Parthenope (Aulacolambrus) hoplonotus (Adams and White).
Parthenope (Aulacolambrus) whitei (A. Milne Edwards).
Parthenope (Parthenolambrus) calappoides (Adams and White).
Daldorfia horrida (Linnæus).
Harrovia truncata Rathbun, nov.
*Calappa calappa (Linnæus).
*Calappa hepatica (Linnæus).
Calappa gallus (Herbst).
Mursia hawaiiensis Rathbun.
Mursia spinimanus Rathbun, nov.
Cycloës granulosa de Haan.
Tlos latus Borradaile.
Tlos angulatus Rathbun, nov.
Ebalia tuberculosa (A. Milne Edwards).
Ebalia jordani Rathbun, nov.
Nucia speciosa Dana.
Randallia distincta Rathbun.
Randallia gilberti Rathbun, nov.
Persephona brevimana (Alcock).
Ethusa mascarone hawaiiensis Rathbun, subsp. nov.
Ethusina gracilipes (Miers).
Hapalocarcinus marsupialis Stimpson.
Callianassa articulata Rathbun, nov.
Callianassa, sp.
Axius pailoloensis Rathbun, nov.
Axius spinosissimus Rathbun, nov.
Axius rudis Rathbun, nov.
Axius serratifrons A. Milne Edwards.
Eiconaxius asper Rathbun, nov.
Paraxius tridens Rathbun, nov.
Scyllarus martensi Pfeffer.
*Scyllarides squammosus (Milne Edwards).
*Parribacus antarcticus (Lund).
Parribacus papyraceus Rathbun, nov.
*Panulirus japonicus (de Siebold).
Panulirus penicillatus (Olivier).
Panulirus marginatus (Quoy and Gaimard).
Polycheles phosphorus (Alcock).
Polycheles snyderi Rathbun, nov.
Polycheles granulatus Faxon.
Polycheles asper Rathbun, nov.
Eryoneicus indicus hawaiiensis Rathbun, subsp. nov.
*Enoplometopus occidentalis (Randall).
*Stenopus hispidus (Olivier).
Spongicola henshawi Rathbun, nov.

THE SHRIMPER, HILO.

From photograph by H. W. Henshaw.

Penæus canaliculatus (Olivier).
*Penæus marginatus Randall.
Metapenæus affinis (Milne Edwards)
Metapenæus velutinus (Dana).
Metapenæus mogiensis (Rathbun).
Metapenæus richtersii (Miers).
Metapenæus evermanni Rathbun, nov.
Solenocera lucasii Bate.
Haliporus equalis Bate.
Haliporus modestus (Smith).
Aristeus semidentatus Bate.
Benthesicymus investigatoris Anderson.
Benthesicymus laciniatus Rathbun, nov.
Benthesicymus moratus Smith.
Benthonectes filipes Smith.
Gennadas parvus Bate.
Gennadas propinquus Rathbun, nov.
Gennadas sp.
Sicyonia lævis Bate.
Sicyonia longicauda Rathbun, nov.
Sergestes tenuiremis Kröyer.
Sergestes robustus Smith.
Sergestes edwardsii Kröyer.
Sergestes oculatus Kröyer.
Sergestes parvidens Bate.
Sergestes armatus Kröyer.
Sergestes ventridentatus Bate.
Leucifer acestra (Dana).
Pontophilus gracilis Smith.
Pontophilus modumanuensis Rathbun, nov.
Egeon orientalis Henderson.
Egeon habereri (Doflein).
Rhynchocinetes rugulosus Stimpson.
Processa processa (Bate).
Processa hawaiensis (Dana).
Hippolyte acuta (Stimpson).
Hippolysmata acicula Rathbun, nov.
Hippolysmata paucidens Rathbun, nov.
Spirontocaris marmorata (Olivier).
Spirontocaris kauaiensis Rathbun, nov.
Spirontocaris profunda Rathbun, nov.
Pandalus martius A. Milne Edwards.
Pandalus ensis (A. Milne Edwards).
Pandalus ocellus (Bate).
Pandalus sindoi Rathbun, nov.
Pandalus brevis Rathbun, nov.
Pandalus exiguus Rathbun, nov.
Pandalus spinidorsalis Rathbun, nov.
Heterocarpus ensifer A. Milne Edwards.
Heterocarpus lævigatus Bate.
Heterocarpus signatus Rathbun, nov.
Heterocarpus alexandri A. Milne Edwards.
Atya bisulcata (Randall).
Ortmannia henshawi Rathbun.
Caridina brevirostris Stimpson.
Harpilius depressus Stimpson.
Coralliocaris quadridentata Rathbun, nov.
Coralliocaris truncata Rathbun, nov.
Periclimenes pusillus Rathbun, nov.
Periclimenes sp.
Oplophorus gracilirostris A. Milne Edwards.
Oplophorus foliaceus Rathbun, nov.
Acanthephyra eximea Smith.
Acanthephyra debilis A. Milne Edwards.
*Bithynis grandimanus (Randall).
Palæmon debilis Dana.
Palæmon pacificus (Stimpson).
Palæmon pandaloides Rathbun, nov.
Palæmonella tenuipes Dana.
Palæmonella orientalis Dana.
Palæmonella laccadivensis Alcock and Anderson.
Gnathophyllum fasciolatum Stimpson.
Nematocarcinus ensiferus (Smith).
Nematocarcinus tenuirostris Bate.
Nematocarcinus gracilis Bate.
Stylodactylus discissipes Bate.
Pasiphæa kaiwiensis Rathbun, nov.
Pasiphæa truncata Rathbun, nov.
Pasiphæa flagellata Rathbun, nov.
Psathyrocaris hawaiiensis Rathbun, nov.
Leptochela robusta Stimpson.

BRACHYURA.

Family OCYPODIDÆ.

Ocypode ceratophthalma (Pallas).

Ocypoda ceratophthalma Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 345, and synonymy.

Hilo, Hawaii[a]; Kailua; Maui, R. C. McGregor; Lanai Beach; Honolulu; Honolulu Reef; Waikiki Beach; Waimea, Kauai; "in coral sand just above high-water mark," Henshaw.

Hawaiian Islands (Dana, as *O. urvillii;* Alcock). Hawaii (Stimpson). Hilo Beach (Miers).

[a] Unless otherwise indicated, specimens were collected by the United States Fish Commission at the localities cited.

Ocypode lævis Dana.

(Pl. VII, fig. 2.)

Ocypode rhombea Randall, Jour. Acad. Nat. Nat. Sci. Phila., VIII, 1839 (1840), 123.
?Ocypoda pallidula Jacquinot, Voy. au Pole Sud, atlas, pl. VI, 1852 (?).
Ocypoda lævis Dana, Crust. U. S. Expl. Exped., I, 325, 1852; pl. XX, fig. 2, 1855.
Ocypoda pallidula Dana, op. cit., p. 324; pl. XX, fig. 1 (type in U. S. Nat. Mus.).
Ocypoda cordimana Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 185 (not all synonymy).

Hilo, Hawaii; Kahului, Maui, R. C. McGregor; Honolulu; Waikiki Beach; Laysan; "in coral sand just above high-water mark," Henshaw.

Hawaiian Islands (Dana), type male in Museum of Comparative Zoology. Hawaiian Islands, J. K. Townsend, one male, specimen labeled by Randall *O. rhombea*, in Philadelphia Academy Natural Sciences. Hilo, Hawaii (Stimpson). Laysan (Lenz, as *urvillei* and probably *cordimana*).

O. lævis is distinct from *O. cordimana* Desmarest.

Ocypode gaudichaudii Milne Edwards and Lucas.

Ocypode gaudichaudii Milne Edwards and Lucas, d'Orbigny's Voy. l'Amér. Mérid., VI, pt. 1, p. 26, 1843; IX, pl. XI, fig. 4, 1847.

Honolulu (Cano). Needs verification.

Uca minor (Owen).

Gelasimus minor Owen, Voy. Blossom, Crust., 79, pl. XXIV, figs. 2, 2a, 1839.

Oahu (Owen).

Uca tetragonon (Herbst).

Gelasimus tetragonum Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 357, and synonymy.

Hawaiian Islands (Kingsley).

Macrophthalmus telescopicus (Owen).

Gelasimus telescopicus Owen, Voy. Blossom, Crust., 78, pl. XXIV, fig. 1, 1839.
Macrophthalmus compressipes Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 123.
Macrophthalmus podophthalmus Eydoux and Souleyet, Voy. Bonite, Crust., 241, pl. III, figs. 6–7, 1842.

Honolulu Harbor, 8 fathoms, one female, collector unknown, in U. S. National Museum. One male, four females, A. Garrett, in Museum of Comparative Zoology.

Oahu (Owen); Honolulu (Cano); Hawaiian Islands (Randall, Eydoux and Souleyet, Dana). One male, two female, types of *M. compressipes* Randall, J. K. Townsend collector, in Philadelphia Academy of Natural Sciences. One male, collected by U. S. Exploring Expedition, in Museum of Comparative Zoology. Hawaiian Islands, W. H. Pease, two males, in Philadelphia Academy of Natural Sciences.

Macrophthalmus inermis A. Milne Edwards.

Macrophthalmus inermis A. Milne Edwards, Ann. Soc. Entom. France (4), VII, 1867, 286; Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 277, pl. XII, fig. 5.

Hawaiian Islands (A. Milne Edwards).

M. convexus Stimpson is quite another species from *M. inermis*. It is much narrower, being not much over half again as wide as long, while *M. inermis* is twice as wide as long. The sides are less convergent posteriorly, gastric and cardiac regions narrower, front wider, about $\frac{1}{6}$ width of carapace, last ambulatory leg much less reduced than in *M. compressipes*.

Libystes nitidus A. Milne Edwards.

Libystes nitidus A. Milne Edwards, Ann. Soc. Entom. France (4), VII, 1867, 285; Nouv. Arch. Mus. Hist. Nat. Paris, IV, 1868, 83, pl. XX, figs. 5–7

Honolulu (Cano).

Pilumnoplax cooki, sp. nov.

(Pl. VII, fig. 3.)

Carapace more convex than usual in the genus, especially fore and aft, about $\frac{3}{5}$ as long as broad, naked, sparingly and irregularly punctate, regions faintly indicated.

Front horizontal, advanced, slightly concave or emarginate; transversely sulcate above the margin, sulcus widest at the middle and tapering to each end; slightly more than a third the greatest breadth of the carapace.

Antero-lateral borders not more than one-half length of postero-lateral, cut into three projections, the first a shallow lobe confluent with the outer orbital tooth, the second a blunt obtuse-angled tooth; edges of teeth sharp. The third prominence is a sharp ascending conical spine directed upward and forward, and situated considerably above the level of the teeth.

Eye of good size, nearly filling the orbit; cornea brown in alcohol. Upper margin minutely notched near the middle, lower margin slightly emarginate below outer angle; inner angle a narrow tooth whose tip is just visible in dorsal view.

The last joint of the peduncle of the antenna attains the edge of the front; flagellum twice as long as the orbit is wide.

Chelipeds in male slightly unequal, heavy, a little more than twice as long as carapace; surface sparingly punctate; arm microscopically granulous, especially toward the margin; a small superior subterminal tooth; wrist less evidently granulous, inner lobe truncate, its distal corner in form of a blunt tooth; hands almost smooth, fingers gaping, the pollex curved downward in its basal half; dark color only on distal two-thirds, the color darkest in the middle, and a brown horn-color at each end.

Legs very slender, long, second pair longest, $2\frac{1}{3}$ times as long as the carapace; smooth, unarmed, nearly bare.

Length of type male 12.7, width 15 mm.

The character of the antero-lateral dentation, as well as the convexity of the carapace, distinguishes this species from all others.

Named for Captain Cook, who discovered the Hawaiian Islands.

Distribution.—South coast of Oahu, 293 to 330 fathoms, stations 3818, 3917; Pailolo Channel, 256 to 290 fathoms, stations 3865, 3866 (type locality), 3883, 3884; northeast approach to Pailolo Channel, 272 to 304 fathoms, stations 4089, 4096; vicinity of Kauai Island, 283 to 309 fathoms, station 4130.

Cat. No. of type, 29364.[a]

Family PALICIDÆ.

Palicus fisheri, sp. nov

(Pl. VII, fig. 5.)

Carapace with regions well marked, covered with minute granules, from each of which a short curved hair arises and with tubercles symmetrically arranged on the summits of the areolæ and coarsely granulate, the chief tubercles disposed as follows: A transverse curved line of about fourteen running from the penult lateral tooth across the cardiac region; three mesogastric; four protogastric, in one line; two epigastric; a cluster of three anterior branchial; smaller tubercles in a line of five or six, and one median in advance of the line on the intestinal region, and three on the posterior part of each branchial region.

Front cut into four narrow lobes, tips upturned, middle pair much lower, longer, more acute, and more depressed than outer pair and separated from each other by a deep U sinus.

Lateral borders moderately diverging posteriorly, cut into five long acute teeth, including orbital, diminishing backward, the last much the smallest. Posterior margin cut into nine to eleven small lobes not contiguous.

Inner supraorbital lobe separated by broad deep sinus from front, its inner angle very prominent and elevated; three deep sinuses in upper margin of orbit; a small V sinus below outer tooth; inner suborbital tooth narrow, acuminate. Eyestalks sharply granular and nodular.

[a] All catalogue numbers of types of new species refer to the catalogue in the U. S. National Museum.

Chelipeds shorter than carapace, unequal in both sexes, only the right or larger one being stouter than the first pair of legs; the upper surface bears some flat lobules and sharp granules; larger palm only a little longer than high.

First pair of legs a little longer than carapace; merus sharply granular, anterior border with four or five small spines and ending in a large sharp-pointed tooth, posterior border denticulate; anterior edge of carpus with a lobe near either end, posterior edge terminating in a small spine; posterior border of last two joints serrulate.

Second and third pairs of legs about $1\frac{3}{4}$ times as long as carapace; merus broadened in middle, with sharp granules or spinules arranged in rows, anterior border with three or more spines increasing distally, a terminal triangular subacute tooth, posterior edge with seven or more spinules, including one terminal; last two joints much widened, anterior border fringed with long hair, posterior border of propodus four to five, of dactylus two to three—serrate.

Fig. 1.—*Palicus fisheri*. station 3982, larger chela of male, × $3\frac{1}{3}$.

Last pair filiform, much shorter than carapace, sharply granular or spinulous up to the dactylus, which is subequal to the propodus.

First segment of abdomen in both sexes carinate, carina granulate and ending in a sharp upturned spine; adjoining segment of sternum armed with a similar spine, which lies just outside the other.

Dimensions.—Male type, length 12, width 14.1 mm. The species grows much larger, an immature female with soft shell, station 4066, measuring 22.6 mm. long and 26.5 wide.

Color.—Legs with broad transverse bands of color.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms, stations 3846, 3847, and 3848; vicinity of Laysan Island, 16 to 163 fathoms, stations 3939 and 3962; vicinity of Kauai Island, 40 to 233 fathoms, stations 3982 and 3987 (type locality); Aleunihana Channel, 49 to 176 fathoms, station 4066; north coast of Maui Island, 99 to 106 fathoms, station 4077. Cat. No. of type, 29368.

Named for Mr. Walter K. Fisher, of Stanford University, who accompanied the Fish Commission party to the Hawaiian Islands in 1901.

This species is allied to *P. serripes* (Alcock & Anderson) and *P. investigatoris* Alcock; differs from the former in having the borders of the carapace more deeply incised and its surface more tuberculate; in *P. investigatoris* the surface is marked by tubercles on the areolæ, but is not granulate, and the teeth of front and posterior margin are more acute.

Palicus oahuensis, sp. nov.

(Pl. VII, fig. 4.)

Carapace quite high in the middle, covered with distant tubercles and granules, between which the surface is microscopically granulate.

Median lobes of front small, round, near together, on a lower level than outer pair, which are broad and very shallow, and separated feebly from the inconspicuous inner supraorbital lobe. Three small notches in upper margin of orbit; outer tooth long, triangular, acute.

Antero-lateral margins forming a very obtuse angle to each other and armed with four teeth besides the orbital; first distant from orbit and lobiform; second and third much larger, subequal, dentiform; last very small, acute. Postero-lateral and posterior margins with a few spaced tubercles.

Chelipeds about as long as carapace (in female) unequal, larger pair not much stouter than first leg; surface granular; larger palm about $1\frac{1}{2}$ times as long as wide, fingers nearly as long as palm and crossing each other at some distance from tip.

First pair of legs a little longer than carapace, merus and carpus granulate, margins of former bluntly denticulate, a prominent blunt tooth at end of anterior margin; two lobes on same margin of carpus; edges of last two joints entire.

Fig. 2.—*Palicus oahuensis*, type female, larger chela, × $4\frac{1}{3}$.

Second and third pairs of legs about $1\frac{3}{4}$ times length of carapace, merus ovate, granular, margins irregularly dentate, teeth smaller and more numerous on posterior than on anterior border; the latter bearing a large terminal tooth, which is larger and acute on second pair, lobiform on third pair; remaining joints similar to those of first pair.

Last pair filiform, granulate, not $\frac{3}{4}$ as long as carapace.

First four segments of female abdomen carinate, first three segments granulate, their carinæ, though not prominent, visible from above.

Dimensions.—Female type, length 7.9, width 10.3 mm. Female, Honolulu Reef, length 8.6, width 11.4 mm.

Record of specimens.—South coast of Oahu Island, 257 to 220 fathoms, station 3919; one female type (Cat. No. 29374). Honolulu Reef; one female.

In the shape and convexity of the carapace this species approaches the West Indian *P. obesus* (A. Milne Edwards), but the antero-lateral borders are more oblique than in the latter.

MANELLA, gen. nov.

Differs from *Palicus* in having the legs of the last pair not different from, or abnormally smaller than, the others. Floor of orbit produced considerably beyond roof. Carapace broadest anteriorly.

The genus *Pleurophricus* was instituted in 1873 by A. Milne Edwards (Jour. Mus. Godeffroy, IV, 84 [8]) for a single species from Australia, *P. cristatipes* (op. cit., pl. I, figs. 6–6c) which no one has since examined. He places it among the Oxystomata near *Orithyia*. In 1879 Miers (Jour. Linn. Soc. London, Zool., XIV, 660) ranged it doubtfully in the Oxyrhyncha, in which he is followed by Haswell (Cat. Austral. Crust., 22, 1882). In 1887 de Man (see below) described a second species of the genus from Amboina, which he believed to be more nearly related to the Corystoidea than to any other group. It is this second species, *P. spinipes*, which is present in the Hawaiian collection, and I am confident that it should be placed in or near the Palicidæ, as, were it not for the normal size and position of the posterior pair of legs, it might be ranged in the genus *Palicus*. The floor of the orbit is a little more advanced than in *Palicus;* otherwise the orbital region, the front, the antennal and buccal regions, the areolation of the carapace, the form of each joint of the first three pairs of legs, the character of sternum and abdomen are essentially those of *Palicus*. The shape of the carapace and chelipeds have less of the typical *Palicus*. The species of that genus which *P. spinipes* most resembles in shape is *Palicus contractus* Rathbun (Bull. Mus. Comp. Zool., XXXIX, 1902, 126, plate, figs. 7 and 8), in which the side margins converge from front to back.

I have separated generically de Man's species from the type of *Pleurophricus* on account chiefly of the legs. In *P. cristatipes* the legs are nearly of a size and the carpus is no longer than broad; while in *Manella spinipes* the first and fourth pairs of legs are much smaller than the second and third, and the carpus is elongate, with the characteristic shape of *Palicus*. In *Pleurophricus* the carapace is subcircular and the chelipeds equal. If the male abdomen resembles that of *Palicus* and *Manella*, then the abdomen of *Pleurophricus cristatipes* represented in fig. 6c (op. cit.) is that of a young female.

This genus is dedicated to Dr. J. G. de Man, one of the most painstaking of carcinologists.

Manella spinipes (de Man).

(Pl. VII, fig. 6.)

Fig. 3.—*Manella spinipes*, station 3847, larger chela of male, × 2⅝.

Pleurophricus spinipes de Man, Arch. f. Naturg., LIII, 1887, 1, p. 344, pl. XV, fig. 1.

Record of specimens.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 28 to 43 fathoms, stations 3872 and 3876.

De Man based the species on a single male, which had the front broken and lacked the right cheliped; the front is four-lobed, the lobes rounded, the middle pair lower and more advanced than the outer; median sinus deep U-shaped. The right chela is 1½ times as high as the left in both sexes, fingers rather short and stout, and when shut leaving a small hiatus at base. In the adult male the greater part of inner surface of hand and fingers of both chelæ is clothed with long hair; in the female and immature male this space is naked, but there is a small dark spot at the center. Besides the long hairs which lie on the upper surface of the last two joints of the legs, there are long hairs fringing the posterior edge of the merus, and in the last pair the anterior edge of the carpus. In the adult the seven segments of the abdomen are all well separated; in the immature the first to sixth segments, inclusive, may be fused.

Dimensions.—Length of male (station 3847) 11.7, width 13.4 mm.

Family GECARCINIDÆ.

Cardisoma rotundum (Quoy and Gaimard).

Thelphusa rotunda Quoy and Gaimard, in Freycinet's Voyage autour du Monde, III, Zool., p. 527, pl. 77, fig. 1 (*Thelphuse chaperon arrondi*), 1825.

Cardisoma hirtipes Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 253; Crust. U. S. Expl. Exped. I, 376, 1852; pl. XXIV, fig. 2, 1855.

Cardisoma rotundum Safford, Contr. U. S. Nat. Herbarium, IX, 1905, 90.

Oahu, H. Mann, 1864, 1 male, 1 female, in Museum of Comparative Zoology.

Family GRAPSIDÆ.

Grapsus grapsus tenuicrustatus (Herbst).

Cancer tenuicrustatus Herbst, Naturg. Krabben u. Krebse, I, 113, tab. III, fig. 33 (not 34), 1783 (not Gronovius). See von Martens, Arch. f. Naturg., XXXVIII, 1872, 107, and Hilgendorf, Monats. K. Akad. Wiss. Berlin, 1878 (1879), 807.

Grapse rude Milne Edwards, Hist. Nat. Crust., II, 87, 1837.

Grapsus hirtus Randall, Jour. Phila. Acad. Nat. Sci., VIII, 1839 (1840), 124.

Grapsus rudis Milne Edwards, Ann. Sci. Nat. (3), Zool., XX, 1853, 168 [134].

Grapsus maculatus var. *tenuicristatus* Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 193.

Hilo, Hawaii; Avalu Point, Lanai Island beach, station 3829; Honolulu market; Papai Oama; Hanalei, Kauai, reef; Necker Island; Laysan; "under stones, high-water mark," Henshaw; Kauai, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Milne Edwards, Gibbes, Randall as *G. hirtus;* 1 male type, J. K. Townsend, collector, in Philadelphia Academy of Natural Sciences; (Dana as *G. pictus*).[a] Oahu (Kingsley). Waikiki, Oahu, and Laysan (Lenz).

Distribution.—The common rock crab of the tropics, *Grapsus grapsus*, is separable into two forms, one in which the lobe on the wrist is very broad and terminates in a short point (*G. grapsus* typical), and one in which the same lobe is narrow and terminates in a long narrow spine (*tenuicrustatus* Herbst). The former inhabits the coasts of America, including the outlying islands, such as the Galapagos, and also the eastern shores and islands of the Atlantic Ocean; the latter is restricted to the oriental region. This division is borne out by the large series in the U. S. National Museum, containing eight localities for *tenuicrustatus*, exclusive of the Hawaiian Islands, and in the Museum of Comparative Zoology, where the same subspecies is represented by nine localities (specimens determined by W. Faxon).

Grapsus strigosus (Herbst).[b]

Grapsus strigosus Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 393.

Oahu, H. Mann, 1864, 3 males, 2 females, approaching subspecies *longitarsis*, in Museum of Comparative Zoology.

Honolulu (Cano); Hawaiian Islands (Kingsley).

Fig. 4.—*Grapsus strigosus longitarsis*. *a*, Left chela of female, station 3881, × 1⅔. *b*, Abdomen of male, Kailua, × 1⅔.

Grapsus strigosus longitarsis Dana.

(Pl. VIII, fig. 1.)

Grapsus longitarsis Dana, Proc Acad. Nat. Sci. Phila., V, 1851, 249; Crust. U. S. Expl. Exped., Pt. I, 339, 1852; pl. XXI, fig. 4, 1855. Paumotu Archipelago.

Grapsus subquadratus Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, 103 [49]. Hawaiian Islands.

Orthograpsus longitarsis Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 195.

[a] See note under *G. strigosus*.

[b] Dana records *G. pictus* from the Hawaiian Islands; his specimens are not extant. A specimen from Paumotu Archipelago labeled by him "*G. pictus*" is in the National Museum and is really *G. strigosus*.

Napili Harbor, Maui, station 3881, 2 females (1 ovigerous). Hawaiian Islands, W. H. Pease, North Pacific Exploring Expedition, 1 female, type of *G. subquadratus* Stimpson. Hawaiian Islands, A. Garrett, 1 female in Museum of Comparative Zoology.

"Under stones below half-tide mark on the ocean shore at Hilo" (Stimpson, unpublished MS.)

A smaller form than typical *G. strigosus*, a female bearing eggs measuring only 24.2 mm. long; also wider and more quadrate; front less advanced; fingers gaping in their basal half; ambulatory legs much longer, $2\frac{1}{2}$ times as long as carapace, meropodites narrowing more distinctly at the distal end, propodites markedly elongate; abdomen of mature female very wide, almost concealing the coxæ of the ambulatory legs; abdomen of male broader, equilaterally triangular from the middle of the third segment to the tip.

The type of Dana's *G. longitarsis* is also in the National Museum; it is a male smaller than the females. I can not see that it differs essentially from the type of *G. subquadratus*.

Dimensions.—Length of larger female from Napili 24.6 mm., greatest width 28.2, width at exorbital angles 23.7, at epibranchial tooth 25.8, width of front below 11.4 mm.

Geograpsus lividus (Milne Edwards).

Geograpsus lividus Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 195.

Hawaiian Islands, A. Garrett, 2 males, in Museum of Comparative Zoology.

Geograpsus crinipes (Dana).

Geograpsus crinipes Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 396.

Oahu, H. Mann, 1864, 1 female, in Museum of Comparative Zoology. Hawaiian Islands, A. Garrett, 1 male, in Museum of Comparative Zoology.

Hawaiian Islands (Dana, Kingsley).

Hemigrapsus crassimanus Dana.

Hemigrapsus crassimanus Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 250; Crust. U. S. Expl. Exped., I, 349, 1852; pl. xxii, fig. 4, 1855.

Hawaiian Islands (Dana).

Metopograpsus messor (Forskål). Native name, *Thukuhar* (Owen).

Pachygrapsus parallelus Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 127.
Metopograpsus messor var. *frontalis* Miers, Ann. Mag. Nat. Hist. (5), V, 1880, 311.
Metopograpsus messor Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 397.

Puako Bay, Hawaii; Hilo; Mauna Loa, beach; Honolulu; Pearl Harbor; Oahu, T. H. Streets; Hawaiian Islands, North Pacific Exploring Expedition, 1 female, in U. S. National Museum, 2 females in Museum of Comparative Zoology, 1 male, 1 female, in Philadelphia Academy of Natural Sciences; Kauai and Maui, A. Garrett, in Museum of Comparative Zoology; Hawaiian Islands, W. H. Jones, in Museum of Comparative Zoology. "Numerous, some under stones at high-water mark," Henshaw.

Hawaiian Islands (Randall, Dana, Streets, Kingsley), 2 males, 3 females, types of *P. parallelus* Randall, T. Nuttall and J. K. Townsend, collectors, in the Philadelphia Academy; also 2 males, 1 female, collected by the U. S. Exploring Expedition. Oahu (Owen); Hawaii (Stimpson); Hilo beach (Miers); Honolulu (Cano); Pearl Harbor, and Waikiki, Oahu (Lenz).

Pachygrapsus plicatus (Milne Edwards).

Pachygrapsus plicatus Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 200, and synonymy.

Kailua; Hilo, Hawaii, H. W. Henshaw.

Hawaiian Islands (Milne Edwards, A. Milne Edwards). Hawaiian Islands, U. S. Exploring Expedition, 2, male and female (Dana); Oahu (Kingsley); Honolulu (Cano); Laysan (Lenz).

Pachygrapsus minutus A. Milne Edwards.

Pachygrapsus minutus A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 292, pl. XIV, fig. 2; New Caledonia. Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 399.

Laysan, May, 1902, 6 males, 1 ovigerous female, smaller than the types, the largest male measuring 4.5 by 6.5 mm., the female 3 by 4.6 mm.

Honolulu (Cano).

Pachygrapsus longipes Rathbun.

(Pl. VIII, fig. 7.)

Pachygrapsus longipes Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 247.

Honolulu (type locality); Honolulu reef; Kealakekua Bay, Hawaii; Hilo, H. W. Henshaw.

Pachygrapsus crassipes Randall.

Pachygrapsus crassipes Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 127.

Hawaiian Islands (Randall). The locality is probably erroneous.

Planes minutus (Linnæus).

Nautilograpsus minutus Kingsley, Proc. Acad. Nat. Sci. Phila., 1880, 202.

Between Erben Bank and Kaiwi Channel, station 3800, on *Velella;* south coast of Oahu, surface, station 3813; south coast of Molokai Island, station 3833, on floating stick.

Cyclograpsus granulatus Dana.

Cyclograpsus granulatus Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 251; Crust. U. S. Exploring Expedition, I, 361, 1852; pl. XXIII, fig. 4, 1855.

Hilo, Hawaii, under stones, high water mark, numerous, H. W. Henshaw. Kahului, Maui, R. C. McGregor. Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology.

Maui (Dana).

Cyclograpsus henshawi Rathbun.

Cyclograpsus henshawi Rathbun, Proc. U. S. Nat. Mus., XXVI, 1902, 75.

Hilo, Hawaii, under stones, high water mark, type locality, H. W. Henshaw. Kahului, Maui, R. C. McGregor. Oahu, Galathea Expedition. Weather coast of Hawaii, A. Garrett, in Museum of Comparative Zoology.

Cyclograpsus cinereus Dana.

Cyclograpsus cinereus Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 251; Crust. U. S. Exploring Expedition, I, 360, 1852, pl. XXIII, fig. 3, 1855.

Hawaiian Islands (Dana).

Sesarma (Sesarma) angustifrons A. Milne Edwards.

Sesarma angustifrons A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, V, 1869, 26.

Collected by W. H. Pease, probably at the Hawaiian Islands, one specimen, in Peabody Museum, Yale University.

Hawaiian Islands (type locality).

Sesarma (Holometopus) obtusifrons Dana.

Sesarma obtusifrons Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 250; Crust. U. S. Exploring Expedition, I, 355, 1852; pl. XXII, fig. 9, 1855.

Hilo, Hawaii, numerous, H. W. Henshaw; a fine series, running larger than Dana's types. The largest male is 15.6 mm. long, 20.5 wide, greatest width of front 13.8 mm. Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology.

Maui (Dana). Hannakakoi, Molokai (Lenz).

Sesarma (Holometopus) trapezium Dana.

Sesarma trapezium Dana, Crust. U. S. Exploring Expedition, I, 354, 1852; pl. xxii, fig. 8, 1855.

Hawaiian Islands (Dana).

Sarmatium faxoni, sp. nov.

(Pl. vii, fig. 1.)

Carapace very little broader than long. Anterior third inclined. Protogastric and anterior branchial regions separately convex. Anterior mesogastric and postorbital regions depressed. H-shaped depression deep. Post-frontal tubercles of the middle pair three times as wide as those of the lateral pair; directly behind the latter and a little posterior to the line of the orbits another pair of elevations similar but wider. Surface of the anterior two-fifths of the carapace covered with coarse rough granules; the remainder with irregular confluent grooves and pits; post-lateral regions obliquely striated.

Surface of front vertical, not visible or only partially visible in dorsal view, very concave horizontally and perpendicularly, granulate; margin thin, along the anterior edge very finely crenulate; in front view this edge nearly horizontal and slightly sinuous, in subdorsal view bilobed; side margins parallel; corners rounded.

Lateral margins of carapace very convex, marked by a narrow smooth rim; three teeth, including the orbital, the first and second directed forward, narrowly acute, sharp-pointed, the first the largest; third tooth obtuse, smallest, directed outward.

Fig. 5.—*Sarmatium faxoni*, abdomen of male cotype, × 4.

Arms with a superior subterminal tooth; outer face crossed by short granular striæ; lower face bordered by spiniform tubercles. Wrist with outer surface very rough with striæ and granules; inner tooth broad, blunt. Hands equal in both sexes, covered outside and in with large, rather distant, sharp granules. A line of smaller granules along upper margin, below which on the inner surface are three or four short oblique granulated ridges. Fingers of male gaping, of female not gaping; upper surface of dactylus armed with horny-tipped spinules, one row of which extends at least to the distal third of the finger; similar spinules on the lower surface of the pollex.

Ambulatory legs long and flat, the third pair between 2 and 2½ times as long as the carapace. The merus joints widen gradually from the proximal end and may attain their greatest width at the subterminal spine or somewhat behind that point; subterminal projection a sharp spine. The propodites are elongate, with subparallel sides.

Abdomen of mature female very wide; last segment deeply set in the preceding.

Dimensions.—Male (Ebon), length, measured from edge of post-frontal lobes 41.2, greatest width 43, exorbital width 30.5, width at posterior epibranchial tooth 38.7, width of front 15 mm.; female (type), length, measured from edge of post-frontal lobes 34.4, greatest width 37, exorbital width 26, width at posterior epibranchial tooth 33.5, width of front 13.5 mm.

Distribution.—Oahu, H. Mann, 1864, one female type (Cat. No. 22837), received from Museum of Comparative Zoology, where there are additional specimens (3 males, 3 females) from the same locality, and three males from Ebon, Marshall Islands, Rev. B. G. Snow, collector.

Named for Dr. Walter Faxon.

This species differs from the typical species of the genus, *S. crassum* Dana, in the vertical front and in the terminal segment of the abdomen of the female deeply impacted in the penultimate segment.

Plagusia depressa tuberculata Lamarck.

Plagusia depressa var. *squamosa* Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 437 (not all synonymy).

Kailua and Hilo, Hawaii; Maui, R. C. McGregor; south coast of Molokai, station 3824; Honolulu; Laysan; Hawaiian Islands, W. H. Pease.

Hawaiian Islands (Stimpson); Laysan (Lenz).

This form is regarded as a subspecies of *P. depressa* because there are intergrading forms. Specimens from Madeira have every appearance of *P. depressa* from the American coast, except that the lobe on the basal joints of the legs is entire, as in true *tuberculata*. *P. immaculata* seems to me a distinct species. The designation *squamosa* Herbst is not used for *tuberculata* Lamarck in view of the fact that there appears to be doubt as to the identity of the type of the former.

Plagusia immaculata Lamarck.

Plagusia immaculata Miers, Ann. Mag. Nat. Hist. (5), I, 1878, 150; Challenger Brachyura, 273, pl. XXII, fig. 1, 1886.

Honolulu (Miers).

Percnon planissimum (Herbst).

Liolophus planissimus Alcock, Jour. Asiat. Soc. Bengal, LXIX, 1900, 439.

Hilo and Puako Bay, Hawaii; Napili Harbor, Maui, station 3881; Honolulu, on coral reef; Hanalei, Kauai, reef; Hawaiian Islands, W. H. Pease; "under stones, high water mark," Henshaw. Maui (Dana). Hawaii (Stimpson). Hawaiian Islands (Milne Edwards, as *Acanthopus affinis*).

Percnon abbreviatum (Dana).

Acanthopus abbreviatus Dana, Proc. Acad. Nat. Sci. Phila., V, 1851, 252; Crust. U. S. Expl. Exped., I, 373, 1852; pl. XXIII, fig. 11, 1855.

South coast of Molokai Island, station 3834; Honolulu; Waikiki Beach.

Percnon pilimanus (A. Milne Edwards).

Plagusia planissima Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 128.
Acanthopus pilimanus A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 300, pl. XIV, fig. 5.
Leiolophus pilimanus Miers, Ann. Mag. Nat. Hist. (5), I, 1878, 154.

Family POTAMONIDÆ.

Trichodactylus punctatus Eydoux & Souleyet.

Without doubt erroneously attributed to the Hawaiian Islands by those authors.

Family PILUMNIDÆ.

Carpilius maculatus (Linnæus).

Carpilius maculatus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 79, and synonymy.

Honolulu; Honolulu market; Puako Bay and Hilo, Hawaii. Oahu, H. Mann, 1864, in Museum of Comparative Zoology.
Honolulu Reefs (Miers); Laysan (Lenz).

Carpilius convexus (Forskål).

Carpilius convexus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 80, and synonymy.

Honolulu, reef and market; Waikiki Beach; Hilo; Waiawa Kanai, V. Knudsen. Oahu, H. Mann, 1864, in Museum of Comparative Zoology.
Hawaiian Islands (Dana); 1 male, 1 female, juv., collected by U. S. Exploring Expedition, in Philadelphia Academy of Natural Sciences; Laysan (Lenz).

Carpilodes tristis Dana.

Carpilodes tristis Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 82, and synonymy.

Hawaiian Islands, A. Garrett, 2 females, in Museum of Comparative Zoology.

Carpilodes ruber A. Milne Edwards.

Carpilodes ruber A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, I, 1865, 228, pl. XI, figs. 4, 4a, 4b.

Honolulu (A. Milne Edwards); Pearl Harbor (Lenz).

Carpilodes coccineus, sp. nov.

(Pl. VIII, fig. 4.)

Surface covered, except in the grooves, with crowded crisp granules visible to the naked eye. Carapace deeply lobulated everywhere. The groove defining the posterior lateral lobe continued to the cardiac region. As in *C. pediger*, the gastric region is divided into four longitudinal lobules and four small anterior lobules, while a shallow transverse furrow cuts off a narrow piece from the posterior extremity of the mesogastric lobule. 1L, 2L, 3L, 4L, 5L, and 6L (of Dana) are separated from one another, although 1L, 3L, and 4L are fused with the corresponding marginal lobes; there is no division between 1R and 2R, while 3R is separate. 2L and 4L have each a dimple on their antero-lateral portion. A broad transverse furrow behind the cardiac region and a narrow one above the posterior margin.

Antero-lateral lobes well marked, the posterior one acutely conical and in young specimens the one next to the last also.

Chelipeds nearly equal, granular like the carapace; two teeth at inner angle of wrist; outer surface of palm with an obscure ridge through the middle and a groove near the upper margin. Fingers slightly gaping. In the old male the gape is less, and the black color of the pollex runs well back on the palm inside and out, but the black of the dactylus does not cover the upper part of the base; tips of fingers light.

Legs granular; carpal joints faintly bilobed.

Color.—"Deep dull crimson lake" all over except the fingers. Color persisting in alcohol.

Dimensions.—Male type, length 13.9, width 23.4 mm.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms, stations 3847 and 3848; Auau Channel, 28 to 65 fathoms, stations 3875 and 3876; Penguin Bank, 28 to 14 fathoms, station 4034, 1 male type (Cat. No. 29422); Hawaiian Islands, A. Garrett, April 25, 1860, in Museum of Comparative Zoology. There is also a male from Mauritius in the U. S. National Museum.

This species comes nearest to *C. pediger* Alcock and *C. cariosus* Alcock. From the former it is distinguished by the coarser granulation, the two teeth on the wrist, the absence of the strong tooth from the base of the movable finger, and by the color; from the latter by the lack of nodules on the chelipeds and legs, by the presence of the small antero-lateral gastric lobule, and by the color.

Carpilodes virgatus, sp. nov.

(Pl. VIII, fig. 3.)

Much like the preceding, *C. coccineus*, but flatter; granulation fine, invisible to the naked eye and occupying the grooves as well as the lobules; groove dividing the protogastric lobules not continued back to the mesogastric area; 2L wider; 2L and 4L not dimpled; antero-lateral lobes less conical, more obtusely pointed.

Surface of chelipeds rougher, the granules on the hand arranged in a reticulating pattern with smooth intervals. Fingers moderately gaping; dark color of the pollex in the male extending back on the palm for two-thirds its length and height. Carpal and propodal joints of legs wider, the former more deeply bilobed than in *C. coccineus*.

Color, bright scarlet, persisting in alcohol, with some small spots of buff which are larger and more confluent on the posterior portion. The legs have about six bands of buff, that on the middle of the merus-joint more or less incomplete or altogether wanting.

Dimensions.—Male type, length 10.8, width 18.4 mm.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 13 to 43 fathoms, stations 3871, 3873, and 3876 (type locality); vicinity of Kauai Island, 68 to 179 fathoms, station 4128. Cat. No. of type, 29432.

Carpilodes vaillantianus (A. Milne Edwards).

Carpilodes vaillantianus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 85, and synonymy.

Honolulu; reef in front of Honolulu; Laysan. Hawaiian Islands, A. Garrett, 1 female in Museum of Comparative Zoology. Hawaiian Islands, W. H. Pease, 2 males in Philadelphia Academy of Natural Sciences.

Color, yellow or greenish yellow; fingers light brown with white tips

Carpilodes monticulosus A. Milne Edwards.

Carpilodes monticulosus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 86.

Honolulu; Laysan. Laysan (Lenz).

Carpilodes supernodosus, sp. nov.

(Pl. VIII, fig. 5.)

Carapace everywhere lobulated, the lobules high and for the most part long and sausage-like, smooth to naked eye, separated by broad deep smooth depressions. Under the lens the surface of the lobules is covered with fine close depressed granulation and irregular pits, some of which are very large.

Protogastric lobule U-shaped; in front of the inner branch only is there an epigastric lobule. The hepatic and branchial lobules extending inward from the lateral lobes are long, irregular, and are incompletely subdivided near their outer ends. 6L is distinct and is subdivided by a transverse furrow; cardiac region flat; two grooves behind it. Lateral projections thick, rounded, well-marked lobes, the first of the four confluent with the orbital lobule and with the subhepatic lobule.

Fig. 6.—*Carpilodes supernodosus*, chela of type, male, × 2⅔.

Chelipeds equal, upper margin of arm denticulate; wrist and upper surface of palm covered with irregular nodules; three longitudinal ridges on outer face of palm, the uppermost formed by a double row of nodules, the second one by a single row, the lower one simply crenulated and prolonged on the finger. Color of index continued a little on the palm. Fingers gaping.

Carpal and propodal joints of legs strongly nodulous.

Dimensions.—Length of male 11.8, width 20.2 mm.

Distribution.—Laysan, May, 1902, one male type (Cat. No. 29424); vicinity of Laysan, 10 to 19 fathoms, stations 3959 and 3960; vicinity of Modu Manu, 27 to 31 fathoms, station 4171.

Color.—A uniform yellowish brown or orange-red.

This species is distinguished from all others by its high smooth nodules and broad interspaces.

Liomera pubescens (Milne Edwards).

Liomera pubescens A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, I, 1865, 223, pl. XII, figs. 6, 6a.

Laysan; south coast of Molokai Island, station 3834.

Color pink, with distant small white spots rimmed with deeper pink; hair yellow.

Liomera prætexta, sp. nov.

Not a typical *Liomera*, because possessed of a crest on the carapace and the carpal joints of the legs.

Carapace of characteristic *Liomera* form, 1.8 times as broad as long, sparingly granulate; from each granule springs a tuft of long yellow hairs which nearly obscure the surface except along the fronto-orbital and antero-lateral borders which are bare and more finely and densely granulate.

Fig. 7.—*Liomera prætexta*, station 3872. *a*, Dorsal view, × 1⅔. *b*, Chela, × 2⅔.

Front deflexed, with two lobes separated by a shallow emargination, from which a deep median furrow arises; lateral angles dentiform, fused with the orbital angles.

Orbits transversely oblong, as in *L. pubescens* (Milne Edwards); the three outer fissures deeply marked.

Antero-lateral border cristiform, cut into four lobes diminishing in size posteriorly, the first confluent with the orbital angle and twice as wide as the second; the third most prominent and twice as wide as the fourth. Lower surface of carapace granulate and in part hairy. Inner angle of basal antennal joint produced and applied along the inner side of the frontal tooth.

Chelipeds equal, small, about 1⅓ times as long as carapace. Upper distal portion of arm, entire outer surface of wrist and upper surface of palm granular and hairy. Upper margin of arm acute,

inner angle of wrist without a tooth, simply bluntly angular. Palms diminishing in width distally; a longitudinal row of granules just below the middle. Fingers long and slender, deeply grooved, narrowly gaping, terminal spoons shallow.

Legs broad, fringed with long hair, especially on the upper margin; posterior surface more or less granular and hairy. Merus joints with an acute upper edge with a row of sharp granules; carpus joints limbed above, the limb bare and continued on the following joint by a small lobe against which the carpal limb fits when the leg is straightened.

Color.—Orange brown in alcohol.

Dimensions.—Female, type, length 10.5, width 18.6 mm.; male (station 3875), length 6.7, width 11.7 mm.

Distribution.—Auau Channel, 28 to 65 fathoms, stations 3872 (type locality), 3875, 3876. Cat. No. of type, 29507.

The limbed carapace and carpopodites as well as the slender chelæ separate this species from other species of *Liomera*.

Atergatis ocyroe (Herbst).

Atergatis floridus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 98, and synonymy.

Oahu, H. Mann, 1864, 4 males, 2 females, in Museum of Comparative Zoology.

Platypodia semigranosa (Heller).

Lophactæa semigranosa de Man, Abhand. Senckenb. naturf. Ges., Frankfurt a. M., XXV, 1902, 582, pl. xxi, fig. 19.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms, stations 3847 and 3848; Auau Channel, 21 to 65 fathoms, stations 3872, 3874, 3875, and 3876; vicinity of Laysan Island, 10 to 19 fathoms, station 3960; Penguin Bank, 27 to 29 fathoms, stations 4031 and 4033; northeast coast of Hawaii Island, 50 to 62 fathoms, station 4055; vicinity of Modu Manu, 30 to 71 fathoms, stations 4149, 4159, and 4164.

In the main points these specimens agree with de Man's description and figure. The tubercles on the palm are, however, fewer and larger, including those on the crest, which are usually five or six in number. The large protuberance on the basal half of the index is broader and less protuberant, and resolvable usually into three smaller teeth not deeply separated. The 23 specimens examined agree in these particulars. The carapace of small specimens and also the propodites of the ambulatories are very much smoother than in the adult.

Platypodia granulosa (Rüppell).

Lophactæa granulosa Alcock, Jour. Asiatic Soc. Bengal, LXVII, 101, 1898.

Hawaiian Islands (Randall); Honolulu Reefs (Miers).

Platypodia eydouxii (A. Milne Edwards).

Lophactæa eydouxii A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, I, 1865, 248, pl. xvi, fig. 2.

Atergatis limbatus Streets, Bull. U. S. Nat. Mus., 1877, No. 7, 105.

Honolulu; Honolulu Reef; Pearl Harbor. Hilo, H. W. Henshaw, "under stones, high-water mark." Oahu, Dr. T. H. Streets, U. S. Navy. Hawaiian Islands, W. H. Pease, in Philadelphia Academy of Natural Sciences; A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (A. Milne Edwards; Streets, as *A. limbatus*). Laysan (Lenz).

This species is very close to *P. granulosa* (Rüppell). The carapace is a little narrower, but more oblong transversely, being relatively wider at the hepatic regions. The lobulation is much less strong, especially noticeable on the protogastric lobes; in *P. granulosa* these lobes are deeply divided; in large specimens of *P. eydouxii* there is a shallow longitudinal groove extending entirely across the lobes, but in small specimens the groove is incomplete posteriorly. The crest on the ambulatory legs is wider in *P. eydouxii*, occupying more than one-third the width of the leg; in *P. granulosa* less than a third.

Among the immature specimens collected by A. Garrett is one with a little deeper lobulation that approaches *P. granulosa*.

Platypodia actœoides (A. Milne Edwards).

Lophozozymus actœoides A. Milne Edwards, Bull. Soc. Entom. France (4), VII, 1867, 273.
Lophactœa actœoides A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 189, pl. VII, fig. 7.

Laysan (Lenz).

Zosimus æneus (Linnæus).

Zozymus æneus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 104, and synonymy.

Oahu, H. Mann, 1864, 1 male in Museum of Comparative Zoology.

Lophozozymus incisus (Milne Edwards).

Lophozozymus incisus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 107, and synonymy.

Laysan (Lenz).

Lophozozymus dodone (Herbst).

(Pl. VIII, figs. 2, 2*a*.)

Lophozozymus dodone Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 108, and synonymy.

Honolulu; Honolulu Reef; Waialua, Oahu; vicinity of Laysan, 10 to 19 fathoms, station 3960; Hilo, H. W. Henshaw.

Lophozozymus intonsus (Randall). Native name, *Kumimi* (Owen).

(Pl. VIII, fig. 8.)

Xantho eudora Owen (not Herbst), Crustacea, in Zool. Capt. Beechey's Voyage to the Pacific in H. M. S. *Blossom*, 1825 to 1828, p. 77, 1839.
Xantho intonsus Randall, Journ. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 113.

Carapace perfectly smooth and polished. Gastric region well delimited and partially subdivided. Two deep grooves run in from the ultimate and the penultimate sinuses of the antero-lateral margin and are united without attaining the gastric region.

Fig. 8.—*Lophozozymus intonsus*, larger chela of male, × ⅔.

Front with two well marked and prominent median lobes; a small but distinct outer lobe is fused with the orbital angle. Surface of the antero-lateral crest concave except of the last tooth. The four teeth are separated by closed fissures; first and second teeth shallow and rounded, the first advanced beyond the orbital angle, but in the same plane; third tooth dentiform, its outer or posterior margin longitudinal and 2½ times as long as its anterior margin; fourth tooth narrow, acute, and bluntly ridged, the ridge continued inward on the carapace.

Chelipeds subequal; upper edge of arm thin, scarcely crested, fringed with long yellow hair and ough with coarse granules, which extend a little way down the outer surface. Surface of wrist and hand covered with very fine granules, forming a reticulated pattern. A very stout blunt tooth at inner angle of wrist; below it a smaller similar tooth, with tubercles and coarse granules at its base. A low blunt crest on upper margin of hand; below it on outer surface four smooth blunt longitudinal crests, of which the two superior are the broader. Fingers long, prehensile teeth very low and fitting close together; color of pollex extending far back on the palm in the male, on the lower margin even to the middle.

Margins of legs clothed with long yellow hair, scantiest on the lower border of the merus and carpus joints. Upper margin sharp but not cristate, that of the merus granulated, as is also its lower margin.

Dimensions.—Male, length 31.8, width 49.5 mm.; female, length 26.2, width 42 mm.; female type, length 32.2, width 49.8 (tip of left posterior tooth broken off).

Distribution.—Kailua, August 1–12, 1901, 1 male, 1 female. Hawaiian Islands, A. Garrett, 1 male, in Museum of Comparative Zoology.

Hawaiian Islands (Randall), 1 female, type in Philadelphia Academy of Natural Sciences. Oahu (Owen).

Near *L. pictor* (Fabricius)=*L. octodentatus* (Milne Edwards), in which the anterior of the lateral teeth is below the level of the outer orbital fissure, the posterior tooth is broader, the hands are not externally carinate, and the legs are conspicuously carinate.

Xantho lacunosus, sp. nov.

(Pl. VIII, fig. 6.)

Fig. 9.—*Xantho lacunosus*, type, male. *a*, Chela, × 1½. *b*, Abdomen, × 1½.

In form and areolation this species bears a striking resemblance to *X. impressus* (Lamarck).[a] Surface everywhere deeply pitted; on the palms the pits elongate, running transversely between irregular longitudinal ridges. Carapace a little narrower than in *X. impressus*, and front less deflexed, so that in dorsal view the true margin of the lobes is visible. Movable finger more strongly deflexed; meropodites of legs with a distinct though blunt superior crest, marked off by a groove. Sixth segment of abdomen of male broader, seventh more broadly rounded. Otherwise as in the related species.

Dimensions.—A smaller species than *X. impressus*. Length of adult male, type, 18.4, width 30.5 mm. Length of egg-bearing female 18.8, width 31.5 mm.

Distribution.—Auau Channel, 32 to 65 fathoms, stations 3872, 3875, and 3876 (type locality). Cat. No. of type, 29588.

Xantho bidentatus A. Milne Edwards.

Xantho bidentatus Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 114.

Hawaiian Islands (A. Milne Edwards, Miers).

Xantho crassimanus A. Milne Edwards.

Xantho (*Leptodius*) *crassimanus* Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 120.

Reef in front of Honolulu; Waialua, Oahu.

In the young the four teeth of the front are slightly developed. The surface of the carapace of both young and middle sized is everywhere conspicuously pitted.

Leptodius exaratus (Milne Edwards).

Xantho (*Leptodius*) *exaratus* Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 118, and synonymy.

Honolulu; Pearl Harbor; Hilo, H. W. Henshaw.

Hawaii (Stimpson).

Leptodius sanguineus (Milne Edwards).

Xantho (*Leptodius*) *sanguineus* Alcock, Jour. Asiatic Soc. Bengal, LXVII, 1898, 119, and synonymy.

Honolulu; Honolulu Reef; Waialua, Oahu; Hilo; Puako Bay and Kealakekua Bay, Hawaii; Napili Harbor, Maui, station 3881; Necker Island; Waikiki Beach, Waianæ; Kailua. One specimen at Honolulu was taken from mouth of *Gymnothorax laysana*. "Under stones, high-water mark" Henshaw.

Hawaiian Islands (Randall, as *Lagostoma nodosa;* Streets). Oahu, Maui and Hilo (Dana); Hilo, 1 female, U. S. Expl. Exped., in Museum of Comparative Zoology. Kannakakai, Molokai (Lenz).

Both forms described by Dana under the names *Chlorodius sanguineus* and *C. nodosus* occur here.

Leptodius molokaiensis, sp. nov.

(Pl. IX, fig. 1.)

Closely allied to *L. exaratus* (Milne Edwards), but a much rougher species. The anterior two-thirds of the carapace in large part rugose, the rugosities composed of sharp granules. Lateral teeth very prominent, acuminate, sides concave and granulate; no supplementary tooth behind the fifth tooth. Lobes of front so deeply hollowed that a small distinct lobe is formed at the outer end.

[a] Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 115.

Chelipeds very rough; wrist nodulous and granulous, a few spinules at inner angle; granules of the hand very uneven and arranged in irregular transverse series, the ridges of the fingers marked by coarse granules. Fingers shorter than in *L. exaratus*, the dactylus strongly hooked and reaching beyond the pollex. Tips of fingers broadly hollowed, a subterminal tuft of hair. Index with a large tooth at its middle, and a smaller one on the proximal side of the first; dactylus with two or three teeth on basal half. Color of index curving moderately back on palm. Merus joints of legs armed with a row of short spines above and sharp granules below on the proximal two-thirds. Last three joints granulous, their margins sharply spinulous.

Fig. 10.—*Leptodius molokaiensis*, larger chela of type male, × 2⅔.

Dimensions.—Male, length 10, width 14.7 mm.; female, length 7.9, width 11 mm.

Type locality.—South coast of Molokai, 43 to 66 fathoms, station 3850; 1 male, 1 egg-bearing female (Cat. No. 29492).

Stimpson, in his unpublished report on the Crustacea of the North Pacific Exploring Expedition, describes and figures many forms which he considers varieties of *Leptodius exaratus*. Our species approaches some of these in the form of the carapace, but is much rougher; none of his species have the meropodites armed with spines.

Leptodius nudipes (Dana).

(Pl. IX, fig. 3.)

Xantho (*Leptodius*) *nudipes* Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 121, and synonymy.

Hawaiian Islands, A. Garrett, 2 males, in Museum of Comparative Zoology.

Carapace deeply areolate. The posterior accessory denticle of the last antero-lateral tooth has the appearance of being on the postero-lateral margin. An oblique groove runs to the middle of the postero-lateral margin.

Front deeply four-lobed, a distinct median V.

The proximal half of the anterior margin of the merus of the ambulatory legs is hairy, as are both margins of the inner surface of the arm of the cheliped.

Length of male 11, width 16.5 mm.

Leptodius gracilis (Dana).

(Pl. IX, fig. 2.)

Chlorodius gracilis Dana, Crust. U. S. Expl. Exped., I, 210, 1852; pl. XI, fig. 13, 1855.

Oahu, H. Mann, 4 males, 2 females, in Museum of Comparative Zoology.

Leptodius waialuanus, sp. nov.

(Pl. VIII, fig. 9.)

Also of the *exaratus* group, but approaching nearer *L. sanguineus*.

Carapace narrower than in any of the allied species. Supplementary tooth wanting, although there is a short granulated ridge, and its complementary groove, leading out to the point where the supplementary tooth exists in *L. sanguineus*. Carapace rather convex, almost smooth posteriorly, irregularly pitted, very finely granulated. Antero-lateral teeth angular, hooked forward, not much projecting, the fifth retreating. Front advanced, median emargination minute, lobes slightly concave, but not subdivided. Inner orbital angles very broad, orbits correspondingly narrow. Cheliped (the left only is present) much as in *L. sanguineus*, but fingers shorter; three superior crests of movable finger each with a lobe at base.

Fig. 11.—*Leptodius waialuanus*, chela of type female, × 2⅔.

Length of female 10, width 13.8 mm.

Waialua, Oahu, 1902, 1 female (Cat. No. 29506).

Xanthodius biunguis, sp. nov.

(Pl. VIII, fig. 10.)

Nearest to *X. cristatus* (Borradaile).[a]

Upper surface thinly coated with coarse tubular hairs, which only partly disguise the markings on the carapace. Gastric region and its subdivisions plainly marked; branchio-hepatic area indistinctly subdivided. Carapace granulate all over.

Front bent down, lobes convex, granulate, outer angles well marked and separated by a rectangular notch from the much thickened and granulate orbital rim. No superior orbital notches; inferior notch very small, terminating a deep fissure. Four low side teeth, or lobes, with granulated edge, the first fused with the orbital tooth. Inner lower angle of orbit prominent, but less advanced than the superior angle.

A low, blunt ridge on the endostome reaches the front edge of the mouth.

Chelipeds unequal, granulate all over except on inner face of arm and lower face of palm; upper and inner margins of arm hairy; inner tooth of wrist blunt; granules of palm large, continued on base of fingers. Fingers grooved, gaping, broadly hoofed at tips, a large tooth at middle of larger pollex, another at base of dactylus.

Fig. 12.—*Xanthodius biunguis*. *a*, Dorsal view of type female, × 2⅞. *b*, Chela of male, Kailua, × 3⅛.

Legs obscurely granulate, long-hairy above; dactyls two-tipped; a curved spine a little stouter than the horny nail is situated just behind or below the latter.

Length of female type 5.4, width 7.8, fronto-orbital width 5.5 mm.

Distribution.—Honolulu coral reef, July 22, 1901 (type locality), Cat. No. 25335; Honolulu, 1891; Kailua, August, 1901.

Medæus ornatus Dana.

(Pl. IX, fig. 5.)

Medæus ornatus Dana, Crust. U. S. Expl. Exped., I, 182, 1852; pl. IX, fig. 1, 1855.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms, stations 3847, 3848, 3850; Auau Channel, 13 to 43 fathoms, stations 3871, 3872, 3874, 3876.

Lahaina, Maui (Dana); Hawaiian Islands (Miers).

The largest male (station 3872) measures 13.8 mm. long, 20.9 broad. In the adult males the fingers of the larger chela are truncate at the tip, the point being turned abruptly inward; the truncate surface is slightly hollowed out. The black color of the immovable finger extends well back on the palm in both chelæ of the male, reaching below nearly to the wrist.

Medæus simplex A. Milne Edwards.

(Pl. IX, fig. 10.)

Medæus simplex A. Milne Edwards, Jour. Mus. Godeffroy, IV, 1873, 79 [3].

Hilo, Hawaii, H. W. Henshaw, two specimens, male and female, the latter ovigerous, both larger than the type, the male measuring 13.4 by 20.2 mm., the female 11.2 by 17 mm.

Cycloxanthops angustus, sp. nov.

(Pl. IX, fig. 6.)

A narrow species, carapace three-fourths as long as wide; gastric region very convex from side to side, antero-lateral limb concave, edges of teeth upturned. Surface deeply areolated posteriorly as well as anteriorly, 2M, 3M, and 5L being especially well marked. Posterior margin beaded, in front of it a transverse ridge. Surface coarsely and unevenly granulate, short-pubescent.

[a] Fauna and Geog. Maldive and Laccadive Arch., I, 252, 1902.

Front three-tenths width of carapace. Margin little convex, two-edged, lower edge closely granulate, upper edge with about eight larger granules, intervening transverse sulcus hairy; median notch shallow, outer angle a prominent blunt tooth, separated by an almost rectangular notch from the inner orbital angle, which is narrower, more spiniform, and more upcurved.

A lobe on upper margin of orbit; outer angle narrow, acute; below it a deep narrow sinus.

Four teeth on antero-lateral margin (besides the orbital), separated by broad sinuses from which furrows run inward on the carapace; margins armed with large acute granules, tip of each tooth near its middle, last tooth smallest.

Basal antennal joint narrow, anterior margin oblique, joining by its inner angle the sharp lower edge of the front and separated by a narrow slit from the sharp-pointed inner angle of the orbit. Lower surface of the carapace hairy and sparingly granulate.

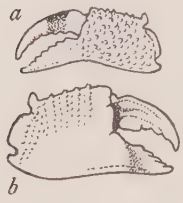

Fig. 13.—*Cycloxanthops angustus*, type female, × 2⅜. *a*, Left chela. *b*, Right chela.

Chelipeds very unequal in both sexes. Surface granulate, arm serrulate above; surface of wrist and upper half of larger hand deeply rugose; carpal tooth narrow, blunt; smaller hand coarsely granulate, especially along upper margin, except on upper half of inner surface, which is deeply grooved. Both hands with a superior longitudinal groove and a tuberculiform tooth at articulation with carpus. Fingers long, grooved, fitting tight together; very large basal tooth on dactylus of larger chela. Color of thumb very slightly continued on palm.

Legs very rough with granulation. Merus joints armed above with cylindrical blunt spines; largest on last pair. Carpal and propodal joints of all the legs and meral joints of last pair deeply grooved across and lengthwise. Legs and proximal half of chelipeds hairy.

Color.—That of iron rust.

Dimensions.—Female type, length 8.8, width 11.6, fronto-orbital width 6.9 mm. Male, station 3847, length 7.8, width 10.9, fronto-orbital width 6.3 mm.

Distribution.—South coast of Molokai Island, 23 to 66 fathoms, stations 3847, 3850 (type locality); Auau Channel, 21 to 28 fathoms, station 3874. Cat. No. of type, 29453.

This species is altogether different from any other described species of *Cycloxanthops*, but approaches nearest to *C. vittatus* (Stimpson), which is wider, smoother, and has more antero-lateral teeth.

Pelœus armatus Eydoux & Souleyet.

Pelœus armatus Eydoux & Souleyet, Voy. Bonite, Zool., I, pt. 2, p. 226; atlas, pl. 1, figs. 10–15, 1842 (*Pelée armé* on plate).

Hawaiian Islands (Eydoux and Souleyet).

Etisus dentatus (Herbst).

Etisus dentatus Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 129, and synonymy.

Oahu, H. Mann, 1864, 1 female in Museum of Comparative Zoology.

Etisus splendidus, sp. nov.

(Pls. III and X.)

Surface as in *E. dentatus* (Herbst).

Antero-lateral border cut into 9 to 13 (exclusive of external orbital angle) procurved teeth, very uneven as to size and place, but about 5 of them larger than the others.

Front more advanced than in *E. dentatus*, the two lobes with slightly concave margins; median sinus not closed, but forming a buttonhole—that is, closed in front, narrowly open behind. Orbits larger; inner angle narrower, and separated by a deeper, rounder sinus from the front than in *E. dentatus*. The space between the two upper fissures of the orbit does not form a tooth; the two inferior teeth are more widely separated than in *E. dentatus*. The lobe of the basal antennal joint extends farther out, filling the whole of the orbital fissure.

Chelipeds in the fully developed male normally very strong and equal, as in the male from Ebon; in the type male from Honolulu market represented in plate X, the right cheliped is probably

abnormally reduced and resembles the chelipeds of the female. The latter are much smaller and either equal or nearly so. Larger arm of type male with three spines above and a good deal of hair proximally; anterior end with a few tubercles. Smaller arm with one spine above. In the female there are many spines and spinules on the upper border, not in a single row, and on the distal margin a row of spines. Wrist with two strong spines at inner angle, one below the other; in the male a few low tubercles on the surface, the larger one behind the articulation with the hand; in the female these tubercles are much more pronounced. Two rows of four or five protuberances each on upper surface of palms, tubercles in male, blunt spines in female. In the male, the fingers of the larger chela are relatively longer than those of the smaller. They are similar to those of *E. dentatus*, but a little wider and the gape correspondingly narrower. In color they are bluish black, edges of spoons white. Fingers of female still shorter and rougher, the two superior ridges of the dactylus armed each with 3 or 4 tubercles on their basal half; color, light brown, which, in the female from Honolulu, extends along the lower surface of the palm for two-thirds of its length, but in the female collected by Mr. Mann extends not at all on the palm.

The legs are much as in *E. dentatus*.

The penult segment of the male abdomen is distinctly broader than long; in *E. dentatus* as long as broad.

Color, brilliant red.

Dimensions.—Type male, length 93.5, width 145 mm.; male, Ebon, length 93.5, width 153 mm.; female, Honolulu, length 77, width 112.7 mm.

Distribution.—Honolulu, 1 female; Honolulu market, 1901, 1 male; 1902, 1 male type (Cat. No. 29464). Oahu, H. Mann, 1864, 1 female, in Museum of Comparative Zoology. Ebon, Marshall Islands, Rev. B. G. Snow, received April 14, 1877, 1 male, in Museum of Comparative Zoology.

This species has a remarkable resemblance to *E. dentatus*, from which it is separated by the characters given above.

Etisus lævimanus Randall.

Etisus lævimanus Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 131, and synonymy.

Honolulu; Honolulu Reef and market, 1 male about 55 mm. wide has the carapace almost concealed by shells, and shells are also attached to the arms and legs. Pearl Harbor, Oahu, Dr. T. H. Streets. Hawaiian Islands, A. Garrett and Dr. W. H. Jones, in Museum of Comparative Zoology; W. H. Pease, in Philadelphia Academy of Natural Sciences.

Hawaiian Islands (Randall, Dana, Streets); one male from Oahu or Maui collected by the United States Exploring Expedition, specimen in the Museum of Comparative Zoology; two males, types, T. Nuttall, collector, in Philadelphia Academy of Natural Sciences. Honolulu Reefs (Miers). Pearl Harbor (Lenz).

Etisodes electra (Herbst).

(Pl. IX, fig. 7.)

Etisodes electra Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 133.

Honolulu Reef; Honolulu; Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology. Hawaiian Islands (Miers).

Hawaiian specimens have been compared with a photograph of the type of *Cancer metis* Herbst, which they closely resemble. The type is a male ^{7} b^{--} 9.4 mm. They also agree with the unpublished figure of Stimpson's *Chlorodius dentifrons*.

Galene hawaiiensis Dana.

Galene Hawaiiensis Dana, Crust. U. S. Expl. Exped., I, 232, 1852; pl. XIII, figs. 5a–b, 1855 (*Hawaiensis* on plate).

Hawaiian Islands (Dana).

Actæa tomentosa (Milne Edwards).

Actæa tomentosa Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 140.

Oahu, H. Mann, 1864, 2 males, in Museum of Comparative Zoology.

Actæa affinis (Dana).

Actæodes affinis Dana, Crust. U. S. Expl. Exped., I, 197, 1852; pl. xi, fig. 3, 1855.
Actæodes tomentosus Miers, Challenger Rept., Zool., xvii, 135, 1886 (part).

Hilo, H. W. Henshaw; Puako Bay, Hawaii; Honolulu; Honolulu Reef; Waialua and Waikiki Beach, Oahu; Laysan.
Hawaiian Islands (Miers, as *Actæodes tomentosus*).

Actæa hirsutissima (Rüppell).

Actæa hirsutissima Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 141, and synonymy.

Puako Bay, Hawaii; Penguin Bank, 28 to 14 fathoms, station 4034; vicinity of Modu Manu, 26 to 33 fathoms, station 4148.

Actæa rufopunctata (Milne Edwards).

Actæa rufopunctata Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 142, and synonymy.

South coast of Molokai, 23 to 24 fathoms, station 3847; Auau Channel, 28 to 43 fathoms, stations 3872 and 3876; Penguin Bank, 28 to 14 fathoms, station 4034; vicinity of Kauai Island, 68 to 179 fathoms, station 4128. Hawaiian Islands, W. H. Pease, 1 male, 1 female, in Philadelphia Academy of Natural Sciences.
Color note on male, station 4034: "Dull brownish-green, nodules red."

Actæa garretti, sp. nov.

(Pl. ix, fig. 8.)

Carapace less than two-thirds as long as wide, ovoid, strongly lobulated, lobules about 27, exclusive of those about front and orbits, densely and finely granulated, separated by smooth grooves filled with long hair, light-colored (in alcohol).

Dorsal surfaces of carpal and propodal joints of chelipeds and legs lobulated like the carapace, and furnished with similar hairs.

Front deflexed so that its margin is not visible in a dorsal view; margin sinuous, with shallow median emargination. Upper margin of orbit tumid, crossed by two furrows and separated by a fissure from the lower margin.

Antero-lateral margin cut into four lobules, and about same length as postero-lateral.

Outer angle of basal antennal joint not quite reaching tip of inner lower angle of orbit.

Outer and lower surfaces of hands coarsely granulate, the granules arranged in three or four lines on outer surface. Fingers in side view acutely pointed, slightly hollowed at tips.

Dimensions.—Largest specimen, female, Hawaiian Islands, length 8.9, width 13.8 mm.; type male, length 7.3, width 11.2 mm.

Distribution.—Hawaiian Islands, A. Garrett; 1 ovigerous female, in Museum of Comparative Zoology. Kingsmill Islands, A. Garrett, 1 male type, U. S. National Museum, Cat. No. 30524; 1 male, 1 female, in Museum of Comparative Zoology. Society Islands, A. Garrett, 1 male, in Museum of Comparative Zoology. Mauritius, 1 male, in United States National Museum.

This species is very near *A. rufopunctata;* the carapace is wider, the grooves are filled with long hair, the lateral margin is split up into 4 instead of 5 lobules.

Actæa speciosa (Dana).

Actæa speciosa Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 143, and synonymy.

Honolulu; French Frigate Shoal, 15 to 16 fathoms, station 3969.
Hawaii, among madrepores, 3 fathoms (Stimpson); Laysan (Lenz).

Actæa variolosa Borradaile.

Actæa variolosa Borradaile, Fauna and Geogr. Maldive & Laccadive Arch., I, pt. 3, 256, text fig. 54, 1902.

Auau Channel, 43 to 32 fathoms, station 3872; Necker Island Shoal, 16 to 171 fathoms, station 3975; vicinity of Modu Manu, 20 to 21 fathoms, station 4168.

Length of male, station 3872, 8.6 mm., width 12.1 mm.

These specimens agree with Borradaile's description, except that the carapace is a little wider. The black color of the immovable fingers extends back on the palm to about the middle of the propodal joint.

Actæa nodulosa White.

(Pl. IX, fig. 4.)

Actæa nodulosa Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 148.

Distribution.—Auau channel, 32 to 43 fathoms, stations 3872 to 3873; Pearl and Hermes Reef, 14 to 29 fathoms, stations 4031 (type locality), 4032 to 4034; northeast coast of Hawaii, 50 to 63 fathoms, station 4063; Aleunihana channel, 49 to 176 fathoms, station 4066; vicinity of Modu Manu, 20 to 33 fathoms, stations 4148 and 4158.

Honolulu reefs (Miers).

In the series collected are several specimens larger than before noted; the largest male is 12 mm. long and 20 wide, the largest female 12.8 by 21.5 mm.

The greater part of the tubercles of the surface are berry-like, covered with granules, either squamiform or acorn-shaped. Chelipeds unequal in the male only; arms high as long, upper margin with two very irregular lobes, on which the granules are sharp; wrist with a moderate tubercle at inner angle and a smaller one below it. Tubercles of palm arranged more or less longitudinally, those of the 3 or 4 uppermost rows very prominent. Fingers very deeply grooved, their basal half roughened, tips acute, when closed leaving a very narrow interspace at base. Dark color of index in male only running far back on palm, almost to proximal end. On the legs the tubercles of the upper surface are elongated into cylindrical spines. Dactyls and lower surface and distal end of propodi tomentose.

Color.—"Coral red and pink mottled."

The very prominent conical lateral lobes give this species a *Xantho*-like aspect.

Actæa hawaiiensis, sp. nov.

(Pl. IX, fig. 9.)

Hawaiian Islands, A. Garrett, 1 male type, in U. S. National Museum (Cat. No. 30523), 2, male and female, in Museum of Comparative Zoology.

A narrow species, somewhat *Pilumnus*-like, convex, not lobulated, posterior two-fifths scarcely areolated. Regions deeply separated from each other. Surface covered with scaly granules or tubercles, larger on branchial and hepatic regions; sparsely hairy, hairs yellow in alcoholic specimens. Protogastric and branchial regions partially subdivided by shallow grooves.

Front moderately deflexed, with deep V-shaped emargination, lobes very oblique. Orbits with two Vs above and one below outer angles. Antero-external angle of basal antennal joint not nearly reaching tip of lower angle of orbit.

Antero-lateral margin dentate and resolvable into four teeth besides the orbital; edges granulated. Some of these teeth may be subd'vided into 2 or 3, except the last, which is narrow, simple, and most upturned. Postero-lateral border equal to chord of antero-lateral border minus posterior tooth.

Wrists and hands coarsely granulate and sparsely hairy, like the carapace; granules somewhat in rows. Fingers elongate, pointed, gaping at base, light brown in alcohol, largest tooth at middle of pollex; dactyls granulate above at base. Color of pollex running far back on palm, in male only, where on lower margin it reaches middle of palm.

Ambulatory legs fringed with hair above; carpal and propodal joints coarsely granulate, the former with a longitudinal groove above.

Dimensions.—Type male, length (to tip of frontal lobes) 13.5, width 18.9 mm.; largest male, 19.5 by 26.6 mm.; female, 19.5 by 26.6 mm.

This species has somewhat the shape of *A. lata* Borradaile, but its sides are more strongly dentate, front more deeply emarginate, fingers longer.

Actæa (?) integerrima (Dana).

Actæodes? integerrimus Dana, Crust. U. S. Expl. Exped., I, 201, 1852; pl. xi, fig. 7, 1855.

Oahu or Maui (Dana).

Banareia villosa, sp. nov.

(Pl. ix, fig. 15.)

Entire surface, except the lobes of the front and orbits, the antennal region and epistome, the distal half of the fingers, and the inner face of chelipeds and legs, clothed with long tubular hairs, which conceal the surface, except for about thirteen large, red, regularly placed granules on the carapace and three antero-lateral lobes partially visible.

Fig. 14.—*Banareia villosa*, type female, × 2⅔.

Carapace three-fourths as long as wide, very convex fore and aft, slightly so from side to side, covered with granules of irregular size, visible when hair is removed; regions well indicated; a high cluster of granules on the hepatic region.

Front deeply four-lobed; orbital margin lobed between sinuses.

Antero-lateral margin with three thick and narrow granulated lobes (besides the orbital); last interspace much greater than the subequal first and second. Postero-lateral margins converging at slightly more than a right angle.

Antennæ as in *B. armata;* basal joint broad, subrectangular, touching the front with the outer half of its distal margin.

Epistome cut by a deep rounded notch on either side.

Chelipeds equal, granulate on outer surface and on upper margin of arm, which has also a large subterminal notch; granules of hand arranged in part serially. Some of the larger and higher granules visible in the midst of the shaggy coating. Fingers bladelike. Dactylus longer than pollex, but folding behind it when closed; a few low prehensile teeth at base.

Granules of legs visible only on removal of hair. Horny tips of dactyls very slender.

Dimensions.—Female type, length 7.2, width 9.2 mm.

Distribution.—Vicinity of Laysan Island, 57 to 130 fathoms, stations 3935, female type (Cat. No. 29411), and 3936, 1 male, soft-shell.

This species differs from the type species of the genus, *B. armata* A. Milne Edwards, and from *B. inconspicua* Miers in its shaggier coat, narrower carapace, naked front.

The characteristic covering and subdorsal position of the last two pairs of legs when flexed give this crab a *Dromia*-like aspect.

Daira perlata (Herbst).

Daira perlata Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 155.

Oahu, H. Mann, 1864, 4 females, in Museum of Comparative Zoology.

Xanthias lamarckii (Milne Edwards).

Xanthodes lamarckii Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 157, and synonymy.

Hawaiian Islands, A. Garrett, 2, male and female, in Museum of Comparative Zoology.

Xanthias flavescens, sp. nov.

(Pl. IX, fig. 11.)

A typical *Xanthias*, of the form of *X. lamarckii*. Surface finely granular except on the postero-medial region.

Orbital region marked off by a groove, gastric region and its three subdivisions well delimited, a well-marked groove extending from the third lateral sinus inward to the gastric region.

Outer angle of front not very pronounced, separated from the supraorbital margin. Groove leading from the orbit faint.

Antero-lateral border divided into four somewhat dentiform lobes (exclusive of orbital angle), the first two very low and preceded by rounded sinuses, the third more dentiform, but very obtusangular, the fifth very small and retreating.

Chelipeds very unequal in the male, stout, granulated; wrist also nodular; granules of palm arranged more or less in transverse series; larger chela very heavy, half as high as length of carapace; fingers of both chelæ stout, grooved, not gaping; the dark-brown color of the index extending halfway back on the palm and also two-thirds its height, inside and out.

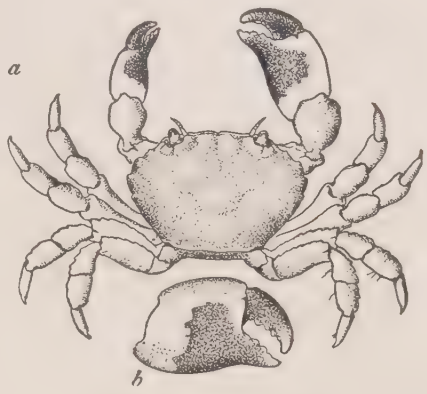

Fig. 15.—*Xanthias flavescens*, type male. *a*, Dorsal view, × 3⅓. *b*, Larger chela, × 4.

Legs finely granular, nearly naked; merus joints minutely serrulate above; next two joints nodular.

A small species, an adult male measuring 4.6 mm. long, 7.2 wide, fronto-orbital width 4.7 mm.

Distribution.—Vicinity of Laysan Island, 79 to 130 fathoms, station 3936 (type locality); Aleunihana channel, 176 to 49 fathoms, station 4066. Cat. No. of type, 29584.

The adult females are only 5.7 and 4.3 mm. wide, respectively. The lateral teeth are more pronounced than in the male, and the chelipeds are very unequal, though less so than in the male.

Color.—The specimens are almost white in alcohol, chelipeds and legs banded with yellow, carapace with a few longitudinal stripes of the same color.

One can separate this from *X. lamarckii* by the smoother carapace, nonacuminate lateral teeth and uneven chelipeds.

Xanthias notatus (Dana).

Xanthodes notatus Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 158.

Honolulu; Waikiki Beach; Laysan.

Hawaiian Islands (Dana, Miers).

Xanthias minutus (Rathbun).

(Pl. IX, fig. 14.)

Xanthodes minutus Rathbun, Proc. U. S. National Museum, XVI, 1893, 238.

Surface smooth, except for the areolations, and shining. Deep grooves separate the fronto-orbital region, the epigastric, protogastric, and mesogastric areas, extend inward from the last two lateral sinuses and cut off the second of the marginal lobules. Hepatic and protogastric lobules faintly divided anteriorly.

Fig. 16.—*Xanthias minutus*, station 4169, chela, × 2⅔.

Front divided into two convex lobes and having a submarginal groove; three distinct grooves in the orbital border. Antero-lateral border cut into four rounded lobes including the orbital. The basal antennal joint runs up a little way alongside the dentiform prolongation from the front, but does not nearly reach the tip of the lower inner angle of the orbit.

Chelipeds subequal; upper border of arm ending in sharp tooth, a subterminal notch; wrists nodose, inner angle bilobed; hands marked by a few longitudinal ridges, the upper of which is somewhat nodose, surface covered with fine reticulating granules. Fingers pointed, not gaping, index grooved, dactylus with lines of punctæ; color of index extending back on the palm.

Legs unarmed; last two joints sparsely hairy; otherwise the crab is devoid of hair.

Dimensions.—Length of male 9.2, width 14, fronto-orbital width 10.5 mm.

Color, a very dark claret; legs with a few transverse bands of a lighter color.

This species was founded on a very small specimen, in which the characters are much less pronounced than in the full-grown.

Distribution.—Kaiwi channel, 14 fathoms, station 3469 (type locality); Aleunihana channel, 176 to 49 fathoms, station 4066; vicinity of Modu Manu, 21 to 26 fathoms, stations 4147, 4169.

Xanthias canaliculatus, sp. nov.

(Pl. IX, fig. 12.)

Surface smooth and shining, irregularly and sparingly punctate. A groove marks off the orbital region and the first two antero-lateral lobes. Gastric region partially limited laterally; only the anterior end of the mesogastric indicated. A short groove running in from the penult sinus of the lateral margin halfway to the gastric region; a still shorter groove running in from the last sinus. Epigastric lobes and outer half of protogastric lobes emphasized by grooves in front of them.

Front one-third width of carapace, deflexed, so that the true edge is scarcely visible from above, with a submarginal groove; bilobed, outer corner pronounced but obtusangular, fused with orbital angle. Orbital margin smooth, three outer furrows shallow; inner lower lobe rounded.

Antero-lateral teeth four, the first two shallow lobes, the first not separated from the orbital angle; the third and fourth dentiform, blunt, smoothly ridged.

Fig. 17.—*Xanthias canaliculatus*, chela of type female, × $2\frac{2}{3}$.

Basal antennal joint with its inner angle just touching the front; outer angle not nearly reaching the tip of the orbital tooth.

Chelipeds equal, short, smooth, and punctate. Arm broader than long, above hairy and granulate; subterminal groove of wrist very deep; a conical obtuse tooth at inner angle and below it a much smaller acute one. On outer face of palm three very deep longitudinal grooves forming corresponding smooth elevations. Fingers (of female) narrow, rather long, fitting close together, dark brown.

Legs smooth outside, very hairy above, last two joints hairy below, merus joints with upper margin sharply granular.

Dimensions.—Female, length 7.9, width 12.9 mm., fronto-orbital width 7.8 mm.

Type locality.—Honolulu, 1901, 1 female (Cat. No. 25343).

This species in its areolation, front and lateral teeth suggests the typical species of *Lophozozymus*, *L. pictor*, but the absence of crests and the great breadth across the front and orbits removes our species from that genus. The deeply fluted hands are its most striking characteristic.

Micropanope sexlobata, sp. nov.

(Pl. IX, fig. 13.)

Carapace about two-thirds as long as broad, slightly convex. Regions well marked, the gastric and its three subdivisions, the cardiac and the intestinal; a groove runs inward from the penult lateral sinus to the gastric region; 1R and 2R are confluent, 3R is distinct; 4L is cut off from 5L, but the latter less completely from 6L; 1M bounded posteriorly by a faint groove. The grooves, besides being deeply impressed, are emphasized by a short pubescence. Surface covered with rather distant sharp granules, finer on the postero-medial portion. Transverse granular ridges traverse the anterior border of the epigastric lobes, the outer half of the protogastric region, and the hepatic region.

Front a little more than one-third as wide as carapace, its anterior portion abruptly deflexed, so that in a strictly dorsal view the lower or true margin is not wholly visible; upper margin truncate, a median U sinus, edge ornamented; the oblique surface of the turned-down front is concave and of very slight depth; its lower or anterior margin, viewed obliquely from above, has a median U sinus; each lobe thus formed is subdivided into three, a narrow submedian lobe, a broad, rounded intermediate lobe, and a small outer triangular lobe which is bent down and just meets with its tip the basal antennal joint. A notch and groove separate the inner orbital angle.

Two triangular notches in the upper margin of the orbit and a larger one below the outer angle; inner suborbital tooth broad and blunt, less prominent than upper angle.

Of the five normal antero-lateral teeth, the orbital is small and inconspicuous, the second is represented only by a granule which projects sharply beyond the other marginal granules; third and fourth teeth of good size, with a sharp point turned forward; fifth tooth very small, indicated rather by the notch and groove in front of it.

Chelipeds very unequal in both sexes, arm short, granulous outside, upper border spinulous; wrist and outer surface of smaller palm, upper half of larger palm coarsely granulous; inner tooth of wrist triangular, sharp; behind and below it a much smaller tooth; the infero-distal half of the larger palm, though smooth to the naked eye, covered with very minute reticulating granules. Fingers of larger chela gaping moderately, a large tooth at base of dactyl.

Legs long and slender, moderately hairy; meropodites armed above with short spinules or sharp granules which are also found on the ridges of the two following joints.

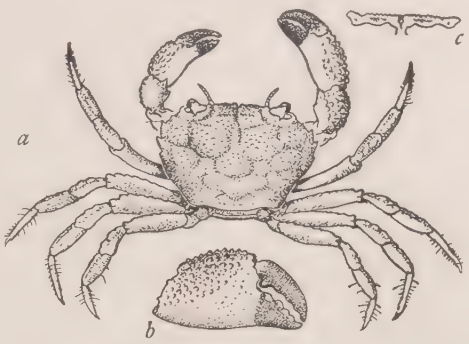

Fig. 18.—*Micropanope sexlobata*. *a*, Dorsal view of type female, × 2⅔. *b*, Larger chela of type male, × 3½. *c*, Front view of front, × 4.

Dimensions.—Male (station 4066), length 5.4, width 8 mm. Female (station 4066), length 5.6, width 8.5 mm.

Distribution.—Vicinity of Laysan Island, 57 to 163 fathoms, stations 3935, 3936, 3939; Aleunihana channel, 176 to 49 fathoms, station 4066 (type locality). Cat. No. of type, 29529.

This species approaches nearest *M. truncatifrons* Rathbun of the West Indies, but the latter is more coarsely granulated, less distinctly areolated posteriorly and the front less evidently six-lobed.

Chlorodiella niger (Forskål).

Eurueppelia sp., Cano, Boll. Soc. Nat. Napoli (1), III, 1889, 102.

Eurüppelia sp., Cano, op. cit., 209.

Chlorodius niger Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 160, and synonymy.

South coast of Molokai, station 3834; Honolulu; reef in front of Honolulu; Laysan; weather coast of Hawaii, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Dana, Stimpson). Honolulu (Cano).

Chlorodiella lævissima (Dana).

Chlorodius lævissima Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 161.

Honolulu; Waikiki Beach; south coast of Molokai, 23 to 73 fathoms, stations 3847 to 3849; Auau channel, 13 to 43 fathoms, stations 3871 to 3874, 3876; vicinity of Laysan, 20 to 30 fathoms, station 3955; Penguin Bank, 28 to 14 fathoms, station 4034; northeast coast of Hawaii, 24 to 83 fathoms, station 4061; vicinity of Kauai, 68 to 179 fathoms, station 4128; vicinity of Modu Manu, 24 to 40 fathoms, station 4163.

Hawaiian Islands (Dana).

The line is not sharply drawn between this species and the preceding. Judging from specimens which have been preserved an equal length of time in alcohol, *C. lævissima* has an orange-reddish color, while *C. niger* is brownish. Adult *C. niger* has the carapace finely granulate under the lens. Adult *C. lævissima* has the central part of the dorsum smooth; young specimens of both are much smoother. Neither is the arching of the fingers, mentioned by Dana and Alcock, to be relied on.

Phymodius ungulatus (Milne Edwards).

Phymodius ungulatus Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 162, and synonymy.

Honolulu; reef in front of Honolulu.

Hawaiian Islands (Streets).

While this species, so far as I have examined specimens, appears to be distinct from *P. obscurus*, yet the chelipeds are not just as described by Alcock, being smoother than in *P. obscurus*. See Borradaile, Fauna and Geography Maldive and Laccadive Arch., I, 259, 1902.

Phymodius obscurus (Lucas).

Chlorodius obscurus Lucas, in Jacquinot and Lucas, Voy. au Pole Sud, Zool., III, Crust., p. 26, 1853; atlas, pl. III, fig. 4, 1852 (?).

Phymodius monticulosus (Dana), Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 163, and synonymy.

Hilo, Hawaii, H. W. Henshaw; south coast of Molokai, station 3834; Honolulu; Honolulu Reef; Oahu, Galathea Expedition, received from Copenhagen Museum; Oahu, Dr. T. H. Streets.

If this species is kept separate from *P. ungulatus*, the name given by Lucas should take precedence of that given by Dana, as the figure at least of the former antedates Dana's work. (See Crust. U. S. Expl. Exped., I, 207.)

Phymodius nitidus (Dana).

Pilodius nitidus Dana, Crust. U. S. Expl. Exped., I, 218, 1852; pl. XII, fig. 7, 1855.

Honolulu; Waikiki Beach; south coast of Molokai, station 3834.

Phymodius laysani, sp. nov.

(Pl. XII, fig. 8.)

Regions of carapace well defined and subdivided by deep grooves, the lobules corresponding very nearly with those in *P. sculptus* (A. Milne Edwards). 1L is, however, separated from the first antero-lateral lobe, 2L and 3L are confluent, 1R is not cut off from the marginal lobe. Surface crisply granulate.

Outer angles of front not separable from the inner angles of the orbit. Orbital fissures very faint.

Antero-lateral border cut into four lobes.

Basal antennal joint touching the front by its inner distal angle, its outer angle prolonged into the gap between front and orbit.

Chelipeds of male equal, short; some hairs on ischium, merus and carpus; arm granulous outside, sharply so above; wrist granulous and nodulous, a blunt tooth inside; hands with granulated nodules above gradually diminishing below to large granules and then to fine granules; granules continued at least half length of fingers; the latter stout, with thick, blunt points, very slightly hollowed.

Legs finely granulous, sharply so on upper margins, which are thickly fringed with long yellow bristles.

Dimensions.—Male type, length 5.8, width 8.3, fronto-orbital width 5.3 mm.

Type locality.—Laysan, May, 1902; 1 male (Cat. No. 29530).

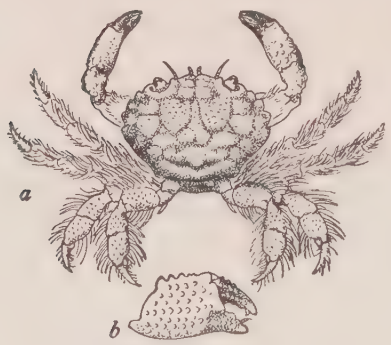

Fig. 19.—*Phymodius laysani*, type male. *a*, Dorsal view, × 2⅔. *b*, Chela, × 3½.

This species, while it has the general appearance of a *Phymodius*, especially of *P. sculptus*, in its naked carapace and chelæ and bristly legs, differs from that genus, as previously known, in the granulation of the surface, in the union of the frontal and orbital angles, in the equal chelipeds, and indistinct spooning of the fingers.

Chlorodopsis areolata (Milne Edwards).

Chlorodius areolatus Milne Edwards, Hist. Nat. Crust., I, 400, 1834.

Etisodes cælatus Dana, Crust. U. S. Expl. Exped., I, 188, 1852; pl. IX, fig. 4, 1855.

Chlorodopsis areolatus A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 231, pl. VIII, fig. 8.

Hawaiian Islands, A. Garrett, 1 female, in Museum of Comparative Zoology.

I think that A. Milne Edwards is correct in his surmise (op. cit., p. 235) that *E. cælatus* Dana is the same as *Chlorodius areolatus* of the elder Milne Edwards, and should be retained in *Chlorodopsis* rather than in *Etisodes*.

The Hawaiian specimen measures 11 by 17.8 mm., fronto-orbital width 11.6 mm. Its antennal flagellum is excluded from the orbit more by the wide contact of upper and lower angles of orbit than by the extension of the basal joint into the hiatus, differing in this regard from the figures both of Dana and A. Milne Edwards.

Chlorodopsis scabricula (Dana).

Pilodius scabriculus Dana, Crust. U. S. Expl. Exped., I, 220, 1852; pl. XII, fig. 9, 1855.

Honolulu, 1891, 1 immature male.

The regions are faintly areolate, minutely scabrous, grooves smooth, lateral projections spines (except the orbital), spine E much smaller but similar to the others.

A row of four lobules parallel to the margin; a similar lobule at 2L.

Lobes of front sinuous, entire to the naked eye, minutely granulous under the lens, outer angle well marked, but not spiniform nor very prominent.

The outer projection of the basal antennal joint reaches as far as the end of the suborbital tooth, but does not exclude the flagellum from the orbital gap.

The tubercles of the wrist and upper surface of palm are large, conical, acute. Upper margin of legs spinulous.

Dana says "tooth E nearly obsolete, hand and carpus very minutely tuberculate." In spite of these discrepancies I place the specimen under *C. scabricula* until the species shall have been better worked out.

Our specimen agrees very well with A. Milne Edwards's description and figure of *C. spinipes*, but it is not the *C. spinipes* of Heller and de Man, in which the orbit has a spine below the outer sinus, nor *C. spinipes* Alcock (Jour. Asiatic Soc. Bengal, LXVII, 1898, 169, ubi syn.), in which the outer angle of the front is spine-like and the carapace coarsely granular.

Chlorodopsis aberrans, sp. nov.

Carapace about three-fifths as long as broad, posterior third not subdivided. Regions and subregions fairly well marked; protogastric lobes lightly and incompletely subdivided. A groove running inward from the penult lateral sinus to the gastric region, otherwise the branchio-hepatic region is undivided. Surface covered with sharp tubercles, irregular in size, as a rule diminishing from in front backward and becoming granules on the postero-medial region. Surface sparingly hairy.

Frontal lobes broad, rounded, granulated, separated by a U-shaped median sinus; a small lobe at outer angle, distinct from the less advanced orbital angle. Orbital margin spinulous; outer emargination of good size.

Antero-lateral projections four, the first a narrow granulated lobe below the level of the orbital angle; the second, third, and fourth, stout spines with granulated borders.

Lower surface of carapace much like the upper. Outer angle of basal antennal joint prolonged a little into the orbital hiatus, but not excluding the flagellum from the orbit, nor nearly reaching summit of inner lower tooth of orbit.

Fig. 20.—*Chlorodopsis aberrans*, type male. *a*, Dorsal view, × 3½. *b*, Chela, × 3¼.

Chelipeds in a male a little unequal; exposed surfaces covered with conical sharp-pointed tubercles which on upper margin of arm, hand, and inner angle of wrist become elongate and spiniform and more or less curved. Tubercles of hand continued halfway along the deeply grooved fingers, which shut tight, their acute tips overlapping. Dark color of thumb in male continued a little way back on palm.

Legs finely granulate, sparingly hairy, margin spinulous.

Dimensions.—Male, length 4.7, width 8 mm.

One specimen only, a male, was taken in the vicinity of Modu Manu, 23 to 26 fathoms, station 4146 (Cat. No. 29434).

This species, although not a typical *Chlorodopsis* by reason of the sharp fingers, nevertheless has much in common with *C. woodmasoni* Alcock, which is more deeply areolated and not so sharply granular.

The orbito-antennal area varies in the species assigned to this genus. In *C. melanochirus* A. Milne-Edwards, the upper and lower angles of the orbit are approximate, the intervening space being evenly filled by the prolongation of the antennal joint; at the same time the flagellum is distinctly excluded from the orbit. In *C. pilumnoides* (White) the upper and lower angles of the orbit are a little farther apart, and the basal antennal joint extends its outer angle into the hiatus, but without filling it or reaching the summit of the lower orbital tooth, or excluding the flagellum. In our species the antenna is much as in *C. pilumnoides*, but the orbital angles are farther apart.

Pilodius flavus Rathbun.

Pilodius flavus Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 239.

Carapace two-thirds as long as wide, rather convex.

With the aspect of a *Pilumnus*. A coating of long yellow hairs does not hide the areolation of the carapace, which is evident to the naked eye. Regions well marked. Protogastric lobes partially subdivided by a short longitudinal furrow. Orbital groove distinct. 1M separate, also 1L (very small), 2L, 3L, 4L, 5L, and 6L; a groove between 2R and 3R. Regions sparingly dotted with irregular rough granules; interspaces smooth.

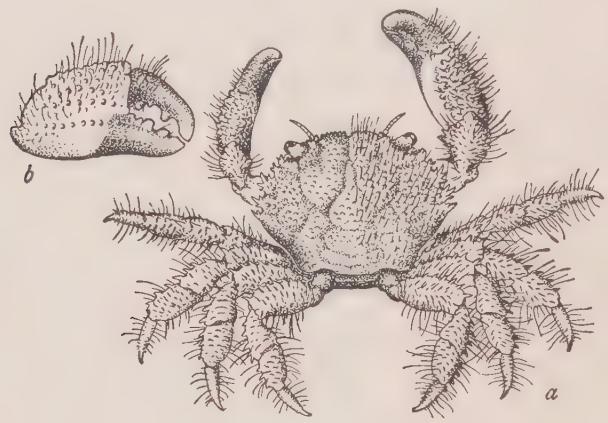

Fig. 21.—*Pilodius flavus*, station 4148, male. *a*, Dorsal view, × 2. *b*, Larger chela, × 2⅔.

Fronto-orbital width three-fourths, front three-eighths, of width of carapace. Frontal lobes of middle pair rounded, granulated, separated by a small U-shaped median sinus; outer lobes bluntly triangular, bent down and separated from the blunt inner angle of orbit by a rectangular notch and a groove. Margin of orbit granulated; two V notches above, a deep open external fissure.

Five antero-lateral spines, including the orbital, which is the smallest; each has one or more accessory spines or spinules; those accompanying the third and fourth spines may be almost as long as the primaries. Parallel to the margin is a row of three sharp conical tubercles, opposite each of the last three marginal spines.

Postero-lateral margins converging so that if prolonged they would meet at slightly more than a right angle.

Lower surface of carapace granulated and hairy. Basal antennal joint broadly touching the lobe of front; outer angle moderately prolonged and reaching end of inner orbital angle; next joint standing in orbital hiatus.

Chelipeds in male very unequal, in female slightly so. Spines on upper border of arm (three to five), outer surface of wrist (two at inner angle), on upper outer surface of palm in rows (where they are more conical), and basal half of dactylus; granules on surfaces and other margins of arm and on middle outer surface of palm, one row continued on thumb. Infero-external surface of palm in larger chela of male smooth and naked; in smaller chela of male and both chelæ of female the spines and hairs cover the whole outer face of palm. Fingers gaping, with spoon tips, prehensile teeth large and irregular. Color line of index slanting obliquely downward across the palm equally in both sexes; tips of fingers white.

Legs spinous; largest spines on the upper margin of carpal and propodal joints, and of the meral joint of the last pair, and also at the distal end of the merus of the other pairs.

Color.—Orange yellow.

Dimensions.—Male, station 4148, length 8.8, width 12.8, fronto-orbital width 9.4 mm.; female, station 4162, length 8.8, width 13, fronto-orbital width 9.5 mm.

Distribution.—Kaiwi Channel, 14 fathoms, station 3469 (type locality); vicinity of Laysan Island, 20 to 30 fathoms, station 3954; French Frigate Shoal, 14½ to 17½ fathoms, stations 3968, 3970; vicinity of Modu Manu, 20 to 160 fathoms, stations 4147, 4148, 4150, 4158, 4159, 4162.

I believe this species is distinguished from *P. pubescens* Dana, de Man,[a] by the rougher carapace, broader front, absence of large spines or teeth from the fore margin of arm (one granule only near the proximal end is enlarged).

Menippe convexa Rathbun.

(Pl. XI, fig. 4.)

Menippe convexa Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 239.

Carapace very convex in both directions, smooth, punctate. Anterior end of mesogastric region indicated; epigastric lobes elevated.

Front a little more than one-fourth width of carapace; lobes very oblique, median sinus V-shaped; outer angle a tuberculiform lobe, separated by a groove from the upper margin of orbit.

Antero-lateral border bluntly rimmed; of the four lobes the first two are very obtusely angled, the last two subacutely so, all near their anterior margin; the first is half as long as the second, second and third subequal; from the fourth a ridge runs inward on the carapace.

Chelipeds in female massive, very unequal; arm and wrist almost smooth, coarsely punctate; on the hand there is a flattened granulation visible to the naked eye. Inner angle of wrist tuberculiform. A large tooth near base of pollex of larger chela.

Dimensions.—Female, length to the tips of frontal lobes 15.5, width 21, width of front 5.8 mm.

Known only from the type specimen, a female taken at Honolulu, collector unknown; specimen in bad state of preservation.

Pseudozius caystrus (Adams and White).

Pseudozius caystrus Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 181.

Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology.

Pseudozius inornatus Dana.

(Pl. XI, fig. 1.)

Pseudozius inornatus Dana, Crust. U. S. Expl. Exped., I, 234, 1852; pl. XIII, figs. 7*a*–7*c*, 1855.

Kailua, Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Dana).

In the male the index finger is only twice as long as its breadth at base.

Length 13.5, width 23.9, width of front, exclusive of orbital angles, 5.3 mm.

Pseudozius triunguiculatus Borradaile.

Pseudozius triunguiculatus Borradaile, Fauna and Geogr. Maldive & Laccadive Arch., I, 242, text fig. 44, 1902.

South coast of Molokai, 8 fathoms, station 3834, one ovigerous female lacking the larger cheliped. Length 3.8, width 5.2 mm.

Platyozius lævis Borradaile.

(Pl. XI, fig. 7.)

Pseudozius (*Platyozius*) *lævis* Borradaile, Fauna & Geogr. Maldive & Laccadive Arch., I, 243, text fig. 45, 1902.

Auau Channel, 28 to 43 fathoms, station 3876; Penguin Bank, 28 to 14 fathoms, station 4034; northeast coast of Hawaii, 50 to 63 fathoms, stations 4055 and 4063; vicinity of Modu Manu, 27 to 31 fathoms, station 4171.

Several specimens are larger than the type, the largest, a female, measuring 10.4 by 13.2 mm. The fronto-orbital region is definitely depressed below the postfrontal surface. Front with a ridge

[a] Abh. Senck. naturf. Ges. Frankfurt a. M., XXV, 619, 1902.

above, behind, and parallel to the margin. The posterior of the lateral teeth is more dentiform than in the young. The anterior border of the merus of the maxillipeds is not notched, as in typical *Pseudozius*.

Ozius hawaiiensis Rathbun.

Ozius hawaiiensis Rathbun, Proc. U. S. Nat. Mus., XXVI, 1902, 77.

Hilo, Hawaii, H. W. Henshaw.

Lydia[a] **annulipes** (Milne Edwards).

Ozius (*Euruppellia*) *annulipes* Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 188, and synonymy.

Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

Pilumnus vespertilio (Fabricius).

Pilumnus vespertilio Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 192.

Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

Pilumnus alcocki Borradaile.

Pilumnus alcocki Borradaile, Fauna & Geogr. Maldive & Laccadive Arch., I, 248, text fig. 48, 1902.

Penguin Bank, 28 to 14 fathoms, station 4034; vicinity of Modu Manu, 33 to 71 fathoms, station 4149.

According to a note by the collector, the color is red; in the alcoholic specimens the hairs are red. The fringe of long hair across the front and the eye peduncles is a most conspicuous feature.

Pilumnus nuttingi, sp. nov.

(Pl. XI, fig. 8.)

Carapace subcircular, four-fifths as long as wide. Hairs for the most part short, not disguising the areolation. Regions, as well as three subdivisions of gastric region, plainly marked. Surface almost smooth.

Fig. 22.—*Pilumnus nuttingi*, type female. *a*, Dorsal view, × 3½. *b*, Larger chela, × 4⅘.

Front cut by a median V into two shallow submedian lobes unarmed; outer lobes not well separated from the small inner angle of the orbit. Three cuts in orbit shallow; margin unarmed, except for short spinule at outer angle.

Antero-lateral about two-thirds as long as postero-lateral margin, cut into three teeth each tipped with a forward-projecting spine. Postero-lateral margins converging at an angle of about 55 degrees.

Basal joint of antenna not quite reaching the front; a deep notch between this joint and acute inner angle of orbit. Lower surface of carapace partly granular.

Chelipeds very unequal in both sexes. Arm with subterminal tooth above; wrist sparingly granulate, sharply angled inwardly; hand stout, covered with acute granules, diminishing inferiorly, arranged mostly in rows; hairs absent from lower distal portion of larger palm. Granules on basal third of dactylus; fingers crossing when closed; prehensile teeth larger in pollex than in dactylus.

[a] *Lydia* Gistel, Naturg. Thierreichs, p. ix, 1848, was substituted for *Eudora* de Haan, 1833, preoccupied, and takes precedence of *Euruppellia* Miers, 1884.

Legs unarmed, thinly clothed with long and short hairs.

Dimensions.—Female type, length 5.5, width 7 mm.; male, station 3848, length 4.5, width 6 mm.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms; stations 3847, 3848; Penguin Bank, 27 to 29 fathoms, station 4032; vicinity of Modu Manu, 24 to 160 fathoms, stations 4150, 4160 (type locality), 4163. Cat. No. of type, 29551.

This species is distinguished by its narrow form, and relative lack of armature, the four antero-lateral spines being the only sharp projections.

Named for Prof. C. C. Nutting, who accompanied the *Albatross* to the Hawaiian Islands in 1902.

Pilumnus acutifrons, sp. nov.

Carapace narrow, seven-sided, smooth, slightly areolated, convex, with scattered tufts of hair.

Frontal lobes deflexed, margin very oblique, subtruncate, finely granulate, separated by a large V, inner angles sharp, outer angles ill-defined and separated by a shallow furrow but no notch from the inconspicuous orbital angle.

Upper orbital notches slight, a spine at outer angle; two spines on lower margin besides the one at the tip of the triangular inner lobe.

Antero-lateral margin with three spines, two of which are larger than the one at the orbit and have broad bases and long slender tips, the last small and bifid at tip.

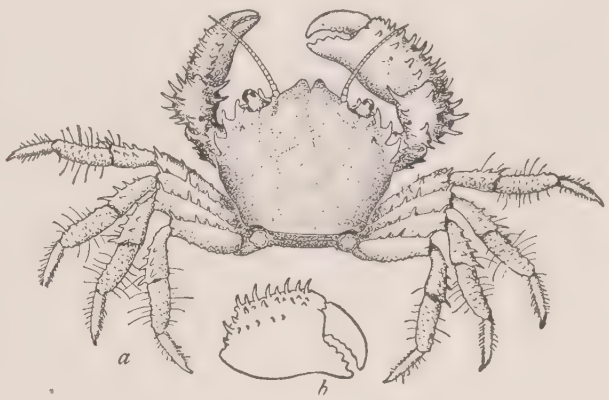

Fig. 23.—*Pilumnus acutifrons*, type male. *a*, Dorsal view, × 6⅔. *b*, Larger chela, × 5⅔.

Chelipeds very unequal in male, spinous; spines on upper margin of arm very irregular, the larger and more distal spines compound; lower margins and upper distal end of outer surface spinulous; wrist armed with about fourteen large curved spines, of which the one at the inner angle is the longer. The large hand is heavy and spinous only on the upper and proximal portion of the outer face, remainder smooth, spines in rows and diminishing from above downward; small hand spinous on the whole outer face. Fingers stout, grooved in small chela, almost smooth in large one, dactyls spinulous proximally, fingers when closed leaving only a very narrow slit at base.

Legs slender, armed above with long, rather distant spines, and below with spinules. Chelipeds and legs sparingly clothed with long hair.

Dimensions.—Male type, length 3, width 3.8 mm.

Type locality.—French Frigate Shoal, 17 to 17½ fathoms, station 3970; 1 male (Cat. No. 29543).

This species has some resemblance to *P. tahitensis* de Man in the oblique lobes of the front and the scattered tufts of hair, but in our species the lobes are more oblique, the orbits and chelipeds are more spinous, the chelæ of different shape.

Pilumnus andersoni de Man.

Pilumnus andersoni de Man, Jour. Linn. Soc. London, Zool., XXII, 1887, 59, pl. III, figs. 5, 6. Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 194. Borradaile, Fauna & Geogr. Maldive & Laccadive Arch., I, 245, 1902.

Vicinity of Laysan, 10 to 19 fathoms, station 3960, 2 females, much smaller than the types, the larger measuring only 6.2 mm. in width. They agree very well with de Man's description, except that the outer orbital angle is sharper, in fact a spine, smaller, however, than the other antero-lateral spines.

Pilumnus tæniola, sp. nov.

(Pl. xi, fig. 3.)

Carapace very wide, about five-sevenths as long as wide; slightly convex transversely, more convex in the opposite direction, the anterior half being strongly declivous; in shape oval-oblong, the postero-lateral margins being not far from parallel; regions scarcely indicated; surface smooth, punctate, pubescent and thinly clothed with long fine hair.

Fronto-orbital width four-fifths width of carapace. Margin of front not visible in dorsal view; lobes convex, most produced in their inner half; outer angle small and inconspicuous, as is also the inner angle of the orbit. Orbit very oblique, margin granulate, without fissures, a slender sharp spine at outer angle; inner lower angle very obtuse, not nearly so advanced as the upper angle.

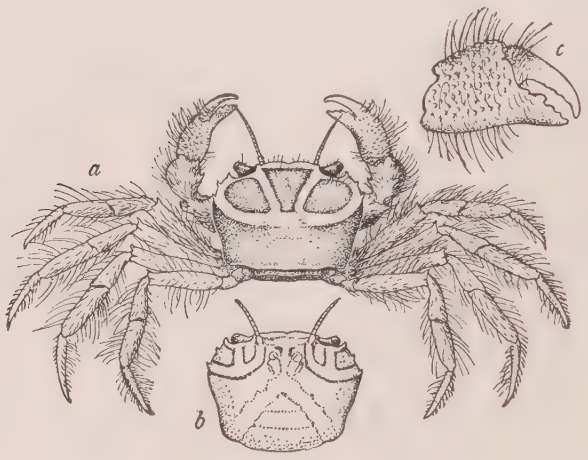

Fig. 24.—*Pilumnus tæniola*, type female. *a*, Dorsal view, × 2½. *b*, Ventral view, showing color markings. *c*, Chela, × 4.

Antero-lateral margin convex, only half as long as postero-lateral and armed with two very small slender spines additional and similar to the orbital and quite independent of the general outline of the carapace.

Antennules stout, transversely folded, basal joint inflated.

Antennæ with basal joint slender, not quite reaching end of lower angle of orbit; second joint loose in orbital hiatus; flagellum long, reaching farther back than posterior lateral spine.

Endostomial ridges well defined, reaching the anterior boundary of the buccal cavern. Outer maxillipeds small, not filling the buccal cavity.

Chelipeds equal in the female (the male lacks a right cheliped), short; arm granulate outside, a sharp-pointed tooth above near distal end, behind it the margin slightly roughened; wrist granulate, a long spine at inner angle, with a shorter one below it; palm higher than its superior length, upper margin very convex, outer surface granulate. Chelipeds and legs clothed with long hairs, which only partially obscure the surface. Hairs and granules continued part way on the fingers. Prehensile teeth of pollex larger than those of dactylus. When the fingers are closed the tips cross and there is a very slight hiatus at base.

Legs long and slender; a slender spine at distal end of upper margin of meral and carpal joints; a longer spine at distal third of the same margin of the merus of each pair except the last.

Abdomen of male with seven separate segments.

Dimensions.—Female type, length 5.8, width 7.7, fronto-orbital width 6.4 mm.; male, station 3876, length 5.6, width 7.1, fronto-orbital width 6 mm.

Distribution.—Auau channel, 28 to 43 fathoms, station 3876; Penguin bank, 28 to 14 fathoms, station 4034 (type locality). Cat. No. of type, 29554.

In regard to the antennæ and maxillipeds this species approaches *Platypilumnus*, but the endostomial ridge clearly reaches the anterior margin of the buccal cavern. The type species of that genus, *P. gracilipes* Alcock, also differs notably in its flat carapace. Our species in its shape approaches *P. rotumanus* Borradaile, which possesses larger antero-lateral spines and more elongate chelæ.

The two specimens agree in characteristic color pattern, being ornamented in the anterior half, both above and below, by light bands bordered on each side with a narrow stripe of dark brown.

Pilumnus ovalis A. Milne Edwards.

Pilumnus ovalis A. Milne Edwards, Ann. Soc. Entom. France, (4), VII, 1867, 280.

Hawaiian Islands (A. Milne Edwards).

Actumnus obesus Dana.

(Pl. XI, fig. 2.)

Actumnus obesus Dana, Crust. U. S. Expl. Exped., I, 244, 1852; pl. XIV, fig. 3, 1855.

In most respects our specimens agree with Dana's description and figures. Dana says, "Antero-lateral margin arcuate, almost entire, very faintly four-lobed, lobes minutely denticulate." In his figure 3*a* no lobes are indicated. His type was considerably larger than the specimens in hand, which show plainly the 3 marginal lobes separated by narrow incisions. The point of each lobe or tooth is at its anterior end, and is marked by a little longer granule or spinule; the teeth project beyond the general marginal line only by the length of this spinule. The areolations are a little more plainly marked than in Dana's figure.

Length of male, station 3849, 9.6, width 12.8 mm.

South coast of Molokai, 43 to 73 fathoms, stations 3849 and 3850.

Lahaina, Maui, dredged (Dana).

Eriphia sebana (Shaw).

Cancer sebanus Shaw, in Shaw & Nodder, Nat. Misc., XV, 1803, pl. 591.

Eriphia lævimana Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 214, and synonymy.

Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

Grapsillus cymodoce (Herbst).

(Pl. XI, fig. 6.)

Trapezia cymodoce Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 219.

Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology.

Grapsillus ferrugineus (Latreille).

Trapezia cymodoce? Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 22.

Trapezia ferruginea Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 220.

Hawaiian Islands, H. Mann and A. Garrett, in Museum of Comparative Zoology; U. S. Exploring Expedition, in Museum of Comparative Zoology.

Hawaiian Islands (Dana, as *T. cymodoce;* Randall, as *T. cymodoce*); 2 males, 3 females, J. K. Townsend, collector, in Philadelphia Academy of Natural Sciences. Honolulu (Cano, as *T. cymodoce*[a]).

Grapsillus ferrugineus intermedius (Miers).

Trapezia maculata Streets, Bull. U. S. Nat. Mus., No. 7, 1877, 106 (not synonymy).

Trapezia ferruginea var. *intermedia* Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 220.

Hilo, H. W. Henshaw; Oahu, Dr. T. H. Streets; Honolulu; Honolulu Reef; Waikiki Beach; Laysan; south coast of Molokai, 8 to 24 fathoms, stations 3834 and 3847; vicinity of Laysan, 10 to 30 fathoms, stations 3955, 3959, and 3962; French Frigate Shoal, 14½ to 16½ fathoms, station 3968; Penguin Bank, 27 to 29 fathoms, stations 4031 and 4032; vicinity of Modu Manu, 26 fathoms, station 4147.

Honolulu reefs (Miers, Alcock).

This subspecies or variety, as also *areolatus* (noted by Alcock), has a very fine scurf-like pubescence on the upper surface of the chelipeds. This must be borne in mind in using Alcock's key to the Indian species of *Trapezia*.

Grapsillus maculatus MacLeay.

Trapezia maculata Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 221. Not *T. maculata* Streets.

Kaiwi Channel, 14 fathoms, station 3469; south coast of Molokai, 23 to 24 fathoms, station 3847; vicinity of Laysan, 10 to 19 fathoms, stations 3959 and 3960; French Frigate Shoal, 14½ to 17 fathoms, stations 3968 and 3971; vicinity of Kauai, 18 to 41 fathoms, station 4023; Penguin Bank, 14 to 29 fathoms, stations 4031, 4032, and 4034.

Hawaiian Islands (Dana, Eydoux and Souleyet, as *T. tigrina*). Hawaii (Stimpson). Laysan, on coral stalk (Lenz).

[a] *T. ferrugginea* mentioned by Cano on pages 90 and 102, is not noticed in his annotated list on page 211.

Grapsillus rufopunctatus (Herbst).

(Pl. XI, fig. 5.)

Trapezia rufopunctata Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 222.

Hawaiian Islands, 1901; Oahu, Dr. T. H. Streets; Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

Honolulu reefs, 18 fathoms (Miers, as *T. rufopunctata* var. *guttata*, p. xxxi, and *T. rufopunctata* var., p. 168). Honolulu (Cano). Hawaiian Islands (A. Milne Edwards, as *T. acutifrons*).

Grapsillus rufopunctatus flavopunctatus (Eydoux & Souleyet).

Trapezia flavo-punctata Eydoux & Souleyet, Voyage Bonite, Zool., I, pt. 2, p. 230, pl. II, fig. 3, 1842.

Hawaiian Islands (Eydoux and Souleyet; A. Milne Edwards, as *T. latifrons*). Laysan (Lenz, as *T. latifrons*).

Grapsillus digitalis (Latreille).

Trapezia digitalis Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 222.

Waikiki Beach; Honolulu; Honolulu reef.

Domecia hispida Eydoux and Souleyet.

Domecia hispida Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1897, 230.

Honolulu; vicinity of Laysan, 10 to 19 fathoms, stations 3960 and 3962; vicinity of Kauai, 18 to 41 fathoms, station 4023; Penguin Bank, 27 to 29 fathoms, station 4032.

Hawaiian Islands (Eydoux and Souleyet). Laysan (Lenz).

Lybia tesselata (Latreille).

Melia tessellata Richters, Beitr. Meeresf. Mauritius u. d. Seychellen, p. 150, pl. XVI, figs. 19–22, 1880.
Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., I, 250, text fig. 49, 1902.

Lybia tesselata Rathbun, Proc. Biol. Soc. Wash., XVII, 1904, 102.

Vicinity of Laysan, 20 to 30 fathoms, station 3955, 1 female; vicinity of Modu Manu, 20 to 30 fathoms, station 4158, 1 female.

Note by the collector of female, station 4158: "This crab held the little sea anemones one in each claw and presented them in a boxing attitude whenever teased or approached by another crab." The anemone is a species of *Bunodeopsis*, according to Dr. J. E. Duerden.

The color markings on the carapaces of these specimens (preserved in formalin) are not in the form of polygons, but except for 6 irregular white patches (2 anterior and 4 posterior) the surface is covered with a labyrinth of fine lines inclosing finer and more broken lines.

Lybia cæstifera (Alcock).

Melia cæstifer Alcock, Jour. Asiat. Soc. Bengal, LXVII, 1898, 231; Illus. Zool. Investigator, Crust., pt. VII, pl. XXXVIII, fig. 4, 1899.

South coast of Molokai, 23 to 24 fathoms, station 3847, one female, 3.5 mm. long by 4.9 wide. I think that this is probably *L. cæstifera*, although the carapace is a little wider than in the type. There are no color lines visible. Otherwise it agrees very well with the description and figure.

Polydectus[a] **cupulifer** (Latreille).

Pilumnus cupulifer Latreille, Encyc. Méth., Hist. Nat., Entom., X, 1825, 124. Ile de France.

Polydectus cupulifera Milne Edwards, Hist. Nat. Crust., II, 146, 1837.

Pilumnus cupulifera Milne Edwards, Cuvier's Règne Anim., disciples ed., atlas, pl. XIV, fig. 4 (figure inaccurate).

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[a] *Polydectus* Rafinesque, Analyse de la Nature, p. 142, 1815, a genus of mollusks, noted in Scudder's "Nomenclator," is a *nomen nudum*.

Polydectus villosus Dana, Crust. U. S. Expl. Exped., I, 227, 1852; pl. XIII, figs. 3 *a–e*, 1855. Raraka Island, Paumotu Group.

Polydectus cupulifer Richters, Beitr. Meeresf. Mauritius u. d. Seychellen, p. 149, pl. XV, figs. 17–20, pl. XVI, figs. 1–8, 1880. Fouquets, Mauritius.

Record of specimens.—Hilo, Hawaii, H. W. Henshaw, 2 males, 3 females. "They occur under stones in 2 or 3 feet of water in a little inlet where the tide continually flows and ebbs. They are by no means rare there, though one has to turn over a number of big stones or coral blocks to find one crab." Vicinity of Laysan, 10 fathoms, station 3959, 1 male.

Three of the specimens hold an actinian in each hand; two specimens, the smallest of all, have an actinian in one hand, not in the other; the sixth specimen lacks the right cheliped altogether, but the left grasps an actinian. These anemones are variable in size. A crab of good size, about 15 mm. in width (devoid of hair) has in one hand an anemone about 10 mm. in diameter, in the other one not more than 6 mm. in diameter. The anemones are firmly grasped by the chelæ, the sharp prehensile spines digging into the flesh; usually the fingers are spread so as to seize opposite sides of the anemone, but in the case of the large one above mentioned the fingers of the crab are flexed and nip into a small bit of the anemone. Compare Richters's description and figures.

Family PORTUNIDÆ.

Carcinides mænas (Linnæus).

Hawaiian Islands, 1 male, in U. S. National Museum, recorded by Streets. (See Streets, Bull. U. S. Nat. Mus., No. 7, 1877, 109; and Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 14.)

Parathranites hexagonum, sp. nov.

(Pl. XII, fig. 3.)

Carapace broad-hexagonal.

Length about four-fifths of width exclusive of spines. Surface strongly areolated, granulated, the granules coarser on the elevated portions; seven high conical tubercles, one on each protogastric area, one posterior mesogastric and in same line one at inner branchial angle, two cardiac side by side. Of smaller tubercles there is one posterior cardiac and three posterior branchial, which form a longitudinal curve with the protogastric and anterior branchial tubercles.

Fig. 25.—*Parathranites hexagonum*, abdomen of type male, × 2⅞.

Front four-toothed, teeth subtriangular, blunt, median pair a little more advanced, median sinus V form, lateral sinuses U form. No tooth at inner angle of orbit. Upper margin of orbit with two open fissures.

Antero-lateral projections, 6; first or orbital narrow, blunt, resembling those of the median frontal pair, and separated by a shallow sinus from the second, which is low and very blunt. Next three regularly dentiform, the third subacutely pointed, the fourth with acuminate tip, fifth with even more slender tip. Sixth projection a spine about twice as long as preceding tooth. Extremities of posterior margin armed with a long upcurved spine.

A blunt tooth at lower inner angle of orbit, more advanced than the front; outer sinus a large V. Orbit about two-thirds as wide as the front. Antennæ and maxillipeds much as in *P. orientalis* (Miers).

Chelipeds one and two-thirds as long as carapace. A subdistal spinule on anterior border of ischium. A strong spine at middle of same border of merus and a spine near distal end of outer border. Spine at inner angle of wrist half as long as palm; a smaller spine at outer angle, and on outer surface five or six blunt spinules. Upper surface of hand with two strong costæ and three spines, of which the inner distal is strongest, distal spine of outer border subterminal. Two indistinct ridges along the inner and the outer surface of the hand. Fingers as long as palm.

Of the first three pairs of legs only the last remain; they are one and two-thirds as long as carapace. Natatory legs unarmed, merus slender.

Second and third segments of abdomen of male strongly carinated; sixth much broader than long, sides slightly converging.

Dimensions.—Male, length 11.8, extreme width 21.5, width to base of lateral spines 15.3, fronto-orbital width 8.7 mm.

Type locality.—South coast of Molokai Island, 92 to 212 fathoms, station 3838; 1 male, immature (Cat. No. 29674).

A young and much-mutilated specimen was taken at station 3982, vicinity of Kauai Island, 233 to 40 fathoms, in which the frontal teeth of the median pair are considerably more advanced than those of the lateral pair and are separated from each other by a very narrow fissure.

P. hexagonum can be told at once from the type species, *P. orientalis*, by the broader, more hexagonal carapace, additional side tooth, and longer side spine.

Parathranites latibrachium, sp. nov.

In shape resembles *P. hexagonum*. Length about three-fourths of width exclusive of spines. Surface with a number of prominent tubercles, lower than in *P. hexagonum;* of these one is protogastric, two side by side on posterior mesogastric, two cardiac behind the preceding, and two forming an obliquely longitudinal line at inner angle of branchial region. A smaller tubercle is anterior mesogastric, and one posterior cardiac. All the elevated portions granulated.

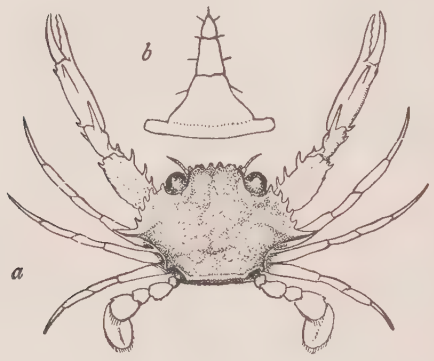

Fig. 26.—*Parathranites latibrachium*, male type. *a*, Dorsal view, × 2⅔. *b*, Abdomen, × 4⅔.

Front more advanced than in *P. hexagonum*, four-toothed, median pair blunt, triangular, about as wide as median sinus, more advanced than lateral pair, which are broad-triangular, subacute, and set off by a U-shaped sinus.

Antero-lateral projections six, the first or orbital blunt, the others becoming slenderer and sharper except the last, which is a long stout spine.

Posterior margin ending in a short upcurved spine.

Lobe at lower inner angle of orbit not nearly so advanced as the front; outer emargination of moderate size. Basal joint of antenna with a narrow outer lobe which runs into the orbital hiatus.

First joint of palpus of outer maxilliped with its inner margin remarkably expanded, forming a vertical lamina. Epistome better defined and more deeply notched than in *P. hexagonum*.

Three spines on inner border of arm, one very small at outer distal end. A long spine half as long as palm at inner angle of wrist and a strong spine at outer angle. Three spines on hand, the inner strong and subdistal, the outer subdistal small, the one above the wrist curved, three additional costæ on outside and two on inside of hand.

Natatory legs unarmed, merus very little longer than wide.

Second and third segments of male abdomen carinated, sixth much longer than wide, sides converging.

Dimensions.—Male, length 6, extreme width 10.8, width to base of lateral spines 8.4, fronto-orbital width 6 mm.

Type locality.—Vicinity of Modu Manu or Bird Island, 20 to 30 fathoms, station 4158; 1 male (Cat. No. 29676).

By the broad merus of the last pair of feet and the lobe on the basal antennal joint, this species is most notably separated from the other *Parathranites*.

Lissocarcinus orbicularis Dana.

Lissocarcinus orbicularis Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 20. Ortmann, Bronn's Thier-Reichs, V, 1900, II Abth., 1239.

Honolulu Reef, May 8, 1902, 1 female; Puako Bay, July 12, 1902, 1 male from a holothurian.

Lissocarcinus lævis Miers.

Lissocarcinus lævis Miers, Challenger Rept., Brachyura, 205, pl. XVII, fig. 3, 1886. Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 21.

Northeast coast of Hawaii Island, 77 to 75 fathoms, station 4057, 1 male.

The two truncate lobes of the front have a sinus a little deeper than in Miers's figure, while the inner angle of the orbit is not so projecting, more rectangular. Surface under the lens finely granular. On the branchial region one can trace a transverse crest running to the last side tooth, which is more slender than figured, while the other teeth are more dentiform.

Fig. 27.—*Lissocarcinus lævis*, station 4057, abdomen of male × 6⅔.

Dimensions.—Male, length 6, width 7.3 mm.

Lupocyclus quinquedentatus, sp. nov.

(Pl. XII, fig. 7.)

Carapace three-fourths as long as wide; hirsute, except on transverse granulated ridges. Ridge connecting teeth of posterior pair interrupted either side of gastric region; in front of it, two gastric ridges, the posterior continuous, the anterior widely interrupted at the middle; behind it a cardiac ridge and on each side three short branchial ridges, the second one of which is interrupted near its inner end. A short post-cardiac ridge; also clusters of granules near the second, third, and fourth antero-lateral teeth, and four clusters more or less distinct on the frontal region.

Front advanced, six-toothed including orbital angle; teeth triangular, acute, middle pair stoutest and most advanced and separated by the most acute sinus; submedian pair smallest, may be a little more or less advanced than the outer pair. Two supra-orbital fissures.

Fig. 28.—*Lupocyclus quinquedentatus*, abdomen of type male, × 1⅔.

Five subequal antero-lateral teeth, sharp-pointed, including the orbital, which is the stoutest, while the last is the most spiniform. A rudimentary tooth in each of the first three sinuses. A curved line joins the posterior and postero-lateral margins.

Outer suborbital fissure V-shaped; inner angle spiniform, much less advanced than upper angle. Outer lobe of basal antennal joint narrow, occupying only half the width of the orbital hiatus.

Chelipeds nearly two and one-half times as long as carapace in male, two and one-sixth times in female; merus very stout with three (occasionally four) large spines on inner margin and a small one at distal end of each margin. Small spine at distal inner end of ischium. Wrist with an inner and two outer subdistal spines. Hand subcylindrical, with three large spines—i. e., the customary one near the wrist, and two at the middle on each side of upper surface; in addition there is on the smaller chela only a small spine on outer distal end, overlapping the dactylus. Fingers slender, longer than palm.

Merus of the natatory feet twice as long as broad, armed with two spines on posterior border, one larger subdistal, one smaller distal. Greater part of posterior margin of propodus armed with small stout denticles. Midrib of dactylus terminating in a spine.

Surface of chelipeds and legs traversed by longitudinal grooves, interspaces for the most part crossed by transverse granulated rugæ.

Abdomen of male broad except for terminal segment, the penult being more than twice as wide as long.

Dimensions.—Male, station 4034, length to median sinus 26.5, width 36.2, fronto-orbital width 22.6; female, station 3876, length to median sinus 27.8, width 37.6, fronto-orbital width 23.9.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 28 to 43 fathoms, station 3876; Penguin Bank, south coast of Oahu, 14 to 28 fathoms, stations 4031, 4034 (type locality); northeast coast of Hawaii Island, 24 to 83 fathoms, stations 4054, 4061; vicinity of Modu Manu, 31 to 56 fathoms, stations 4160, 4164. Cat. No. of type, 29669.

Color.—According to a note by the collector, the type male is "translucent yellowish, heavily mottled with vermilion. Dorsum of carapace nearly clear red, ventral side whitish."

This species differs from *L. rotundatus* Adams & White in the greater prominence of the inner orbital angles, fewer lateral teeth and arm spines, and more numerous lines on the carapace.

Goniocaphyra inæqualis, sp. nov.

(Pl. XII, fig. 9.)

Bears a strong resemblance to the type species of the genus *G. truncatifrons* de Man, of which there is a female specimen from Samoa in the U. S. National Museum.

Carapace narrower; anterior and antero-lateral regions finely and evenly granulate, the coarse antero-lateral granules of the older species being absent. Side teeth similar in number and position; no denticle between first and second, the suborbital region being very finely granulate. In front view the orbits diminish in height outwardly.

Fig. 29.—*Goniocaphyra inæqualis*, station 3876, abdomen of male, × 4⅛.

Chelipeds much more unequal in the male than in the related species, the smaller one twice as long as the carapace is wide, the larger one about two and a quarter times as long. The borders of the inner surface of the arm are coarsely granulous, and are devoid of the spines of *truncatifrons*. The smaller chela of the male is similar to that in the last-named species, but the larger chela is very heavy, the fingers very short, being less than two-thirds as long as the palm.

Dimensions.—Male, length 7, width 10.6 mm.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 13 to 43 fathoms, stations 3871 (type locality), 3872, 3873, 3874, 3876; vicinity of Kauai Island, 68 to 179 fathoms, station 4128. Abundant at stations 3847 and 3876. Cat. No. of type, 29657.

Carupa læviuscula Heller.

Carupa læviuscula Heller, Verh. zool. bot. Ges. Wien, XII, 1862, 520; Reise Novara, Crust., 27, pl. III, fig. 2, 1865. Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 26.

Honolulu, 1 male, 1 female.

Laysan (Lenz).

Portunus sanguinolentus (Herbst).

Cancer sanguinolentus Herbst, Naturg. d. Krabben u. Krebse, I, 161, pl. VIII, figs. 56, 57, 1783.
Neptunus sanguinolentus Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 32.

Honolulu; Pearl Harbor; Oahu, Dr. T. H. Streets; Heeia; Hilo; Hilo Bay, H. W. Henshaw; south coast of Oahu, surface, station 3813; Kaunakaki Harbor, Molokai, station 3844; north coast of Molokai, surface, stations 3889 and 3905; Pailolo Channel, 30 to 52 fathoms, station 3861; Auau Channel, 14 fathoms, station 3870; south coast of Oahu, surface, station 3921; Hawaiian Islands, U. S. Exploring Expedition, 1 male, 1 female; Maui, lee coast of Oahu and weather coast of Hawaii, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Randall, Dana, Streets), 4 males, 2 females, J. K. Townsend, collector, in Philadelphia Academy of Natural Sciences. Hawaii (Miers). Haunakackai, Molokai (Lenz).

This may be the "*Neptunus diacanthus*" recorded by Cano from Honolulu.

Note on this species at Hilo, by H. W. Henshaw, July 26, 1898: "The common bay crab, numbers of which are brought in every time the fishermen draw their nets. They look much like our Chesapeake crab, and the Kanakas catch them in the same manner—circular net, baited with a bit of meat or fish—as the crabs are caught along the Eastern Shore."

Portunus pubescens (Dana).

(Pl. XIV, fig. 1.)

Lupa pubescens Dana, Crust. U. S. Expl. Exped., I, 274, 1852; pl. XVI, fig. 9, 1855.
Achelous pubescens A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, 342.

Honolulu; Honolulu market; Maui, R. C. McGregor; Kauai, A. Garrett, in Museum of Comparative Zoology.

Maui (Dana).

Portunus (Achelous) argentatus (A. Milne Edwards).

Neptunus argentatus A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, 332 and 339, pl. xxxi, fig. 4.

Honolulu (Cano).

Two young specimens, each about 3 mm. long, from the surface on north coast of Molokai Island, station 3889, belong to the *argentatus* group, but are too small to be determined with certainty.

Portunus (Achelous) granulatus (A. Milne Edwards).

(Pl. xii, fig. 2.)

Lupea granulata A. Milne Edwards, Hist. Nat. Crust., I, 1834, 454.

Neptunus (Achelous) granulatus Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 45.

Distribution.—South coast of Molokai Island, surface and 43 to 66 fathoms, stations 3846, 3850; Auau Channel, 21 to 28 fathoms, station 3874; vicinity of Modu Manu, 20 to 31 fathoms, stations 4158, 4159; Hilo, 1901; Oahu, H. Mann, 1864, in Museum of Comparative Zoology, determined by W. Faxon.

Laysan (Lenz).

Portunus (Achelous) orbicularis (Richters).

(Pl. xii, fig. 4.)

Achelous orbicularis Richters in Möbius, Meeresf. Maurit., 153, pl. xvi, figs. 14, 15, 1880.

Neptunus (Achelous) orbicularis Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 47.

Vicinity of Laysan Island, 16 fathoms, station 3962.

Portunus (Xiphonectes) longispinosus (Dana).

(Pl. xii, fig. 6.)

Xiphonectes longispinosus Doflein, Abh. math.-phys. Cl. k. bayer. Akad. Wiss., München, XXI, 1902, 659, pl. v, fig. 7.

Portunus (Xiphonectes) longispinosus Rathbun, Bull. Mus. Comp. Zool., XXXIX, Dec., 1902, 130, and synonymy.

Honolulu Reef; Hilo; weather coast of Kauai, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Dana).

Fig. 30.—*Portunus (Xiphonectes) longispinosus*, Honolulu Reef, abdomen of male, × 2⅞.

Portunus (Xiphonectes) macrophthalmus sp. nov.

(Pl. xii, fig. 5.)

Allied to *P. (X.) longispinosus*. Fronto-orbital width less; median pair of frontal teeth narrower, submedian pair more triangular; orbits narrower and more deeply cut. Antero-lateral spines fewer (four or five), excluding the orbital and the long lateral spine; in *P. longispinosus* they are usually six (occasionally seven), divisible into two sets, the two anterior separated by a wider space from the four posterior. Outer tooth of orbit narrow, acutely pointed; inner suborbital lobe triangular; merus of last pair of legs unarmed; crest of third segment of male abdomen very prominent, notched in the middle; penult segment longer than broad, much constricted.

Fig. 31.—*Portunus (Xiphonectes) macrophthalmus*, abdomen of type male, × 3¼.

Dimensions.—Male, station 4160, length 11.9, entire width 27.5, fronto-orbital width 10.4; female, station 3986, length 4.7, entire width 9.7, fronto-orbital width 4.9 mm.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; vicinity of Kauai Island, 362 to 55 fathoms, station 3986; vicinity of Modu Manu, 31 to 39 fathoms, station 4160 (type locality). Cat. No. of type, 29688.

Charybdis japonica (A. Milne Edwards).

(Pl. XIII, fig. 2.)

Portunus (*Charybdis*) *6-dentatus* de Haan, Fauna Japon., Crust., 41, pl. XII, fig. 1, 1835. Not *Cancer sexdentatus* Herbst.

Goniosoma japonicum A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, 373.

Charybdis japonica Rathbun, Proc. U. S. Nat. Mus., XXVI, 1902, 27.

Honolulu, U. S. S. *Tuscarora*, 2 females. Honolulu, collector unknown, 1 male, 1 female.

This species is, I think, the one described and figured by de Man (Jour. Linn. Soc. London, XXII, 1888, 80, pl. V, fig. 2) as *Goniosoma affine* Dana, but it differs from the true *Charybdis affinis* of Dana in the following characters:

C. affinis is wider across front and orbits; front less advanced and less arcuate; side teeth a little concave on their outer slope, making them appear narrower. In *affinis* the merus of swimming feet is nearly as broad as long, while in *japonica* it is one and a half times as long as broad. Penult segment of male abdomen with sides more convex in *affinis*, so that the segment is widest at its middle, while in *japonica* it is widest at proximal end.

There are in the Museum of Comparative Zoology specimens of *C. affinis* from Singapore and Penang, collected by Capt. W. H. A. Putnam.

The *Charybdis affinis* of Alcock (Jour. Asiat. Soc. Bengal, LXVIII, 1899, 56) must be a different species, as it has a transverse ridge on the cardiac region, contradictory to the descriptions by Dana and de Man.

The species grows to be quite as large as *C. cruciata;* and it may be noted that one of the conspicuous differences between these two lies in the merus of the last pair of legs, which in *C. cruciata* is shorter or three-fourths as broad as long (not three-fourths as long as broad) and in *C. japonica* two-thirds as broad as long.

Charybdis erythrodactyla (Lamarck, 1818).

(Pl. IV.)

Thalamita pulchra Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 117, pl. IV.

Goniosoma erythrodactylum A. Milne Edwards, Arch. Mus. Hist. Nat. Paris, X, 1861, 369, and synonymy.

Puako Bay, Hawaii; Honolulu; Honolulu market; Oahu, H. Mann, 1864, in Museum of Comparative Zoology; Waiawa, Kauai, Valdemar Knudsen; Kauai, A. Garrett, in Museum of Comparative Zoology.

Hawaiian Islands (Randall), 2 females, types of *T. pulchra*, Nuttall and Townsend, in Philadelphia Academy of Natural Sciences; length of larger, measured to tips of frontal teeth, 161.5, width 188.8 mm.

Honolulu (Lenz).

Fig. 32.—*Charybdis orientalis*, Honolulu, abdomen of male, × 4/3.

Charybdis orientalis Dana.

(Pl. XIII, fig. 1.)

Charybdis orientalis Dana, Proc. Acad. Nat. Sci. Phila., VI, 1852, 85; Crust. U. S. Expl. Exped., I, 285, 1852; pl. XVII, fig. 10, 1855. Not *C.* (*Goniosoma*) *orientalis* Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 63.

Carapace about two-thirds as long as broad; four series of transverse granular ridges, the posterior of which connects the last pair of side teeth; surface pilose except on the ridges and margins and two bare spots on the cardiac region.

Front cut into 6 truncated teeth, not including the inner orbital angles. Antero-lateral borders with 5 large teeth, the last not larger than the others; a small denticle at outer base of first tooth. Posterior border arcuate and curving into the postero-lateral borders; below the marginal rim at either end of posterior border there is a smooth lobule.

Major diameter of orbit less than one-fourth width of inter-orbital space, the lobe at lower inner angle dentiform, obtusangular, the lobe below the outer angle distinct, not dentiform.

Arm with 3 spines on the anterior border and one on the posterior border; wrist with a strong spine at the inner angle, 3 small spines on the outer side; 5 large spines on upper surface of hand.

Upper surface of arm, wrist, and hand covered with large granules. Four longitudinal granulated crests on outside of hand below the spines and 2 on the inside; intermediate spaces filled by short transverse granulated costæ, which also ornament the outside of the arm. Hands swollen. Fingers with deep pilose grooves separating high smooth ridges.

Merus of fifth pair of legs only one and a half times as long as its width at middle, armed with a long distal spine on posterior border. The hind margin of the propodus is armed with a few scattering short, blunt spinules.

Penult segment of abdomen of male a little wider than long, sides subparallel except at distal end.

Dimensions.—Male, length from base of median notch 51.3, entire length 53.2, width 74 mm.

Distribution.—Honolulu, 1 male. Specimens from the Philippine Islands (including the type) and the Society Islands in the Museum of Comparative Zoology.

Honolulu (Lenz).

Thalamonyx gracilipes A. Milne Edwards.

Thalamonyx gracilipes A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IX, 1873, 169, pl. iv, fig. 3. Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 71.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 21 to 43 fathoms, stations 3872, 3874.

Thalamita cœruleipes Jacquinot.

Thalamita cœruleipes Jacquinot, in Jacquinot & Lucas, Voyage au Pole Sud, Zool., III, Crust., p. 53, 1853; atlas, pl. v, fig. 6, 1852 (?).

Oahu, H. Mann, 1864, in Museum of Comparative Zoology; determined by W. Faxon.

The postero-lateral angles of the carapace are marked by a rimmed lobe outside the usual postero-lateral ridge. Posterior margin of propodus of natatory legs armed with six or seven spines increasing distally.

Thalamita picta Stimpson.

Thalamita picta Stimpson, Proc. Acad. Nat. Sci. Phila., X, 1858, 39.

Waikiki Beach; Honolulu; Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

Thalamita sima Milne Edwards.

Thalamita sima Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 81.

Hawaiian Islands (Cano).

Thalamita integra Dana.

Thalamita integra Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 85.

Hilo; Honolulu Reef; Honolulu, U. S. S. *Tuscarora* and Dr. W. H. Jones; Pearl Harbor; Oahu, Dr. T. H. Streets.

Honolulu, 16 to 20 fathoms (Miers); Honolulu (Alcock); Honolulu market, also Hawaii (Miers); Oahu (Lenz); Hawaiian Islands (Dana, Streets).

Thalamita edwardsi Borradaile.

Thalamita edwardsi Borradaile, Proc. Zool. Soc. London, 1900, 579; Fauna and Geog. Maldive and Laccadive Islands, I, 1902, 202.

In the Hawaiian collections are found three forms which come within the *admete* group.

The first or smoothest (*T. edwardsi* Borradaile) is tolerably abundant on the coral reefs, though much less so than *T. integra*. The cardiac region is devoid of a crest, and there are only faint traces of its continuation on the branchial regions; fourth lateral tooth rudimentary, minute, often not discernible. Of the crests on the hand the two uppermost are granulous and each armed with two spines, those of one series alternating with those of the other, the distal extremities armed with a blunt tooth; third crest obsolete; fourth strong and smooth in the young or in the old, obsolete except toward extremities of palm; fifth well developed, smooth; space between first and second crests finely granulous, also halfway to third crest (if such were developed).

The second form is rather rare on the reefs, and is characterized by a distinct crest on the cardiao region and in the same line a short and distinct crest on each branchial region; fourth lateral tooth well developed, but smaller than the others. The five crests of the hand are well developed and granulous, the granules diminishing in size from the third to the fifth crest; the terminal projections of the two upper crests may be acute or spinous; space between first and third crests coarsely granulous, which granulation may extend to the fourth crest.

The third form inhabits deeper water and occurs in considerable numbers at some stations. All the crests are as strong as or even stronger than in form 2; the fourth tooth is rudimentary as in *edwardsi;* five crests of hand all well developed and granulous, the space as far down as the fourth crest coarsely granulous, some granulation just above the fifth crest, two spines in first row, three in second; lower surface of hand granulous, also a portion of inner surface.

Distribution of T. edwardsi.—Honolulu, U. S. S. *Tuscarora,* Dr. W. H. Jones and U. S. Fish Commission; Honolulu Reef; Waikiki Beach; Oahu, Dr. T. H. Streets; Hanalei, Kauai, reef; Hilo; Maui, A. Garrett, in Museum of Comparative Zoology; Hawaiian Islands (Dana, Streets, as *T. admete*).

The only variation from the typical *edwardsi* is noted in a female from Honolulu (Cat. No. 25379) in which the fourth tooth is better developed, and the hands tend toward the roughness of form No. 3.

There are in the National Museum no specimens from elsewhere than the Hawaiian Islands.

The second form I have called *T. admete* (Herbst), because it seems to me that the specific name *admete* should be applied to a form in which the fourth side tooth is well developed. Herbst's type of *Cancer admete* is not extant (cf. Hilgendorf, Monats. K. Akad. Wiss. Berlin, 1878, 799), therefore one must rely on his description and figure.

Thalamita admete (Herbst).

Cancer Admete Herbst, Natur. d. Krabben u. Krebse, III, pt. 3, p. 40, pl. LVII, fig. 1, 1803.

Herbst shows in his figure a fourth tooth of good size and moreover says "der vierte Zahn ist aber weit kleiner, als die übrigen, mehr dornenartig, und hat das Ansehen, als sey er als ein junger zwischen den beyden grösseren hervorgewachsen."

Distribution.—Laysan, May 1902; Waiawa, Kanai Island, V. Knudsen, 1887.

Specimens of the same are in the National Museum from Anamba Islands in the China Sea, Samoa, and Lord Howe Island.

The description of *T. savignyi* A. Milne Edwards applies very well to these specimens except that the inner face of the hand is not granulous.

While I may be mistaken in naming this form, I think that it is more nearly correct than the application of "*admete*" made by Alcock (1899) and Borradaile (1902).

Thalamita auauensis, sp. nov.

(Pl. XII, fig. 1.)

The third form of the *admete* group described above is not found in Borradaile's key (loc. cit. 1902), hence a new name is proposed.

A different specific designation seems to be warranted for each form of the Hawaiian series and no striking intergradations are to be seen in the collection in the National Museum from other localities, which, however, is very limited.

Named for Auau Channel where this crab is the most plentiful.

Distribution.—South coast of Molokai Island, 23 to 73 fathoms, stations 3847, 3849, 3850; Auau Channel, 13 to 43 fathoms, stations 3871, 3872, 3873, 3876 (type locality); northeast coast of Hawaii Island, 24 to 83 fathoms, station 4061; vicinity of Kauai Island, 68 to 179 fathoms, station 4128; vicinity of Modu Manu, 26 to 183 fathoms, stations 3978, 4147, 4149, 4161, 4164. Cat. No. of type, 29602.

Thalamita spinifera Borradaile.

Thalamita exetastica var. *spinifera* Borradaile, Fauna and Geog. Maldive and Laccadive Arch., I, 203, 1902.

The specimens agree with Borradaile's description in having the chelipeds covered to a large extent with rounded granulations instead of squamæ and the lower side almost smooth (that is, smooth

to the naked eye, but really microscopically squamose); and the propodite of the swimming foot armed posteriorly with spinules.

It may be added that the subspecies is much larger and wider than typical *exetastica*, the largest male (station 3876) measuring 19 mm. long by 27.1 wide, the largest female (station 3850) measuring 17.2 by 25.2 mm.

The characters of the eighty specimens examined agree except that in those of medium size there is some variation in the size of the secondary tooth at the base of the first tooth, it being sometimes rudimentary, sometimes plainly developed; in large specimens it is a slender spine of good size.

Distribution.—South coast of Oahu Island, 238 to 52 fathoms, station 3811; south coast of Molokai Island, 23 to 212 fathoms, stations 3838, 3847 to 3850; Auau Channel, 13 to 65 fathoms, stations 3871 to 3876; vicinity of Kauai Island, 24 to 233 fathoms, stations 3982, 3987, 4002, 4024, 4128; northeast coast of Hawaii Island, 24 to 113 fathoms, stations 4057, 4061, 4062, 4063.

Thalamita alcocki de Man.

Thalamita alcocki de Man, Abh. Senckenb. naturf. Ges. Frankfurt a. M., XXV, 1902, 646.

Vicinity of Modu Manu or Bird Island, 26 to 33 fathoms, station 4148, one ovigerous female, 7.7 mm. long, 11.6 wide, fronto-orbital width 9.6 mm.

Thalamita kukenthali de Man.

Thalamita kukenthali de Man, Abh. Senckenb. naturf. Ges. Frankfurt a. M., XXV, 1902, 650.

Aleunihana Channel, 176 to 49 fathoms, station 4066; one male, 8 mm. long, 11.4 wide, fronto-orbital width 10 mm.

In this specimen the cardiac crest can scarcely be made out.

This and the preceding species differ from *T. exetastica macrodonta* Borradaile (Fauna and Geog. Maldive and Laccadive Arch., I, 203, 1902) in having spines on the hinder edge of the last propodite.

Podophthalmus vigil (Fabricius).

Podophthalmus vigil Miers, Challenger Rept., Zool., XVII, 207, 1886, and synonymy.

Honolulu, Pearl Harbor; lee coast of Oahu, A. Garrett, in Museum of Comparative Zoology; Heeia; Mauna Loa, beach; Hilo.

Hawaiian Islands (Gibbes, Randall), 4 males, Nuttall and Townsend, collectors, in Philadelphia Academy of Natural Sciences. Honolulu Reefs (Miers). Honolulu (Lenz).

Family CANCRIDÆ.

Kraussia integra (de Haan).

(Pl. XIV, fig. 3.)

Kraussia integra Alcock, Jour. Asiat. Soc. Bengal, LXVIII, 1899, 97, and synonymy.

Distribution.—Vicinity of Laysan Island, 20 to 30 fathoms, station 3955, 1 female with eggs; northeast coast of Hawaii Island, 50 to 63 fathoms, station 4063, 1 juv.

Kraussia rugulosa (Krauss).

Kraussia rugulosa Dana, Crust. U. S. Expl. Exped., I, 302, 1852; pl. XIX, fig. 1 a-f, 1855. De Man, Arch. f. Natur., LIII, 1887, 1, p. 343, pl. XIV, fig. 2.

Island of Maui (Dana).

Kraussia hendersoni Rathbun.

(Pl. XIV, fig. 2.)

Kraussia nitida Henderson, Trans. Linn. Soc. London (2), V, 1893, 379, pl. XXXVII, fig. 9.

Kraussia hendersoni Rathbun, Bull. Mus. Comp. Zool., XXXIX, 1902, 133.

I have not seen *K. rugulosa*, but to judge from the figures given by Dana and de Man (loc. cit.), the carapace is more orbicular, narrower through the hepatic region, the fingers are longer and quite otherwise in shape, and there are three or four antero-lateral teeth evident behind the orbital tooth.

One egg-laden female of *K. hendersoni* was taken at station 3876, Auau Channel, 28 to 43 fathoms. It differs from a Samoan example in having the submedian lobes of front as advanced as the lateral pair; the granules which make up the rugæ of the palm and also those on the fingers are more elevated and are plainly visible to the naked eye.

PLATEPISTOMA, gen. nov.

Epistome broad (from side to side), its posterior margin well defined and not overlapped by the outer maxillipeds. Merus of latter as broad as long, its antero-external angle produced. Buccal cavity widening anteriorly.

Carapace suborbicular, margins spinous. Eyestalks very stout, filling the orbits. Basal joint of antenna longer than wide, filling the orbital hiatus.

In the well-defined buccal cavity in which the maxillipeds neatly fit, this genus is not a typical Cancrid, and approaches the Pilumnidæ; the genus *Telmessus* is perhaps nearest of the Cancridæ; in all other respects it has the characteristic appearance of the family. In the form of the carapace it has much the aspect of *Hypopeltarium;* the basal joint of the antenna is not far removed from *Atelecyclus.*

It is unfortunate that this new form should be represented in the collection by only a young specimen; but, although the adult may differ, it is obviously not possible to place the species in any known genus.

Platepistoma macrophthalmum, sp. nov.

Carapace slightly wider than long, suborbicular with a fairly well-marked lateral angle, moderately convex in both directions; regions indicated, surface uneven, pubescent and covered with sharp granules, with longer spinules on the summits of the areolæ.

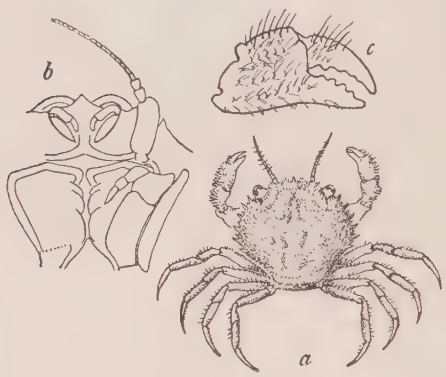

Fig. 33.—*Platepistoma macrophthalmum*, type female. *a*, Dorsal view, × 3⅛. *b*, Antennal and buccal area, × 10. *c*, Chela, × 9⅜.

Front appearing tridentate; the median tooth small, triangular, bent down to the interantennular septum; the lateral teeth are shallow lobes formed by upper margin of antennulary fossettes.

Orbits shallow, large, a little wider than high and completely filled by the eyes; upper margin spinulous and cut by two small V-shaped notches.

Antero-lateral and postero-lateral margins subequal, the former convex and cut into five large, alternating with four small, spines, the spines broad at base and slender pointed. On the straight postero-lateral margin there is a spine of medium size, next the lateral angle, followed by several spinules.

Lower orbital margin with a small round sinus not far from its middle; inner angle tipped with a spinule, but slightly more advanced than outer angle.

Basal segment of antennules large, suboblong, tapering distally. The same segment of antennæ is long, reaching for half its length beyond the lower orbital angle and meeting the upper orbital angle, sides subparallel, concave inner margin forming external boundary of antennular cavity. Movable part of antennæ half as long as carapace. Epistome short, posterior margin notched behind middle of antennules.

The buccal cavity widens perceptibly anteriorly. Maxillipeds not at all pediform. Merus wider than ischium, wider than long, antero-external angle much produced laterally and rounded; anterior margin transverse. Exognath surpassing in length the endognath.

Chelipeds equal and of moderate size, much as in *Telmessus;* spinulous, spinules arranged in longitudinal series on the palm, and largest on upper surface. Fingers furrowed, dentate on inner edges and fitting together when closed.

Legs of moderate size, merus and carpus joints minutely spinulous above, with a longer terminal spinule. Horny nail very long and slender, occupying nearly one-third of dactylus. The whole animal is covered with a pubescence, which must be removed in order to see the spinulation and granulation.

Dimensions.—The single specimen, which is a young female, measures only 4.2 mm. long and 4.7 wide.

Type locality.—North coast of Maui Island, 238 to 253 fathoms, station 4083, 1 female (Cat. No. 29791).

Family INACHIDÆ.

Achæus affinis Miers.

Achæus affinis Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 172.

Distribution.—South coast of Molokai Island, 60 to 64 fathoms, station 3845; vicinity of Laysan Island, 163 to 59 fathoms, station 3939; northeast coast of Hawaii Island, 50 to 63 fathoms, station 4063; north coast of Maui Island, 56 to 59 fathoms, station 4072.

Achæopsis superciliaris Ortmann.

Achæopsis superciliaris Ortmann, Zool. Jahrb., Syst., VII, 1893, 36, pl. III, fig. 3.

Distribution.—Vicinity of Laysan Island, 163 to 59 fathoms, station 3939; north coast of Maui Island, 57 to 58 fathoms, station 4076.

The specimens which I have referred here are much smaller than that figured by Ortmann, the largest measuring 4.7 mm. in length. They are, however, adult, most of the females being laden with ova. The margin of the rostral lobes, as well as the supra-ocular margin, is spinulous. The spine above the posterior branchial margin represented by Ortmann is indicated only by a tubercle. Nevertheless, I think it very probable that they are the same species.

Cyrtomaia smithi Rathbun.

(Pl. VI.)

Cyrtomaia smithi Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 229.

A large species.

Surface covered with rough granules, carapace finely pubescent anteriorly. Regions well marked. Three gastric spines, the posterior median the smallest; cardiac region divided by a shallow longitudinal depression into two swellings each tipped with a spine. Other spines are as follows: One small anterior branchial; a submarginal branchial row continued on the pterygostomian region; a prominent spine at outer angle of orbit and another on upper margin, a line of spinules between and in line with the upper orbital and the larger gastric spine; one or more median gastric spinules; a small marginal hepatic spine. Rostral spines short, conical, horizontal, interspace V-shaped; median subrostral spine equally strong. Spines of carapace diminishing in size with age.

Basal joint of antennæ with outer and anterior margin spinulous.

Chelipeds in male three and three-fourths times as long as body, armed with spines and spinules; merus nearly as long as propodus, the longest spine on the innermost row. Palms enlarging distally, a row of strong spines on middle of inner and of outer face; protuberances of upper surface very coarse. Fingers irregularly toothed, narrowly gaping. Palms of female much more slender.

First pair of legs four or five times as long as carapace, spines of last two joints extremely long and slender on the lower or posterior side, forming in flexion a formidable weapon. Other legs rapidly diminishing in length, strength, and armature, the last pair being two and a half times length of carapace and devoid of spines except one at tip of merus. In the old the penult pair is equally devoid of spines. In the young the last three pairs are very nearly of a length.

Sternum armed with spines mostly slender. First and sixth segments of abdomen in both sexes with a distal median spine; second to fifth segments, inclusive, with two distal submedian spinules.

Dimensions.—Male, station 3984, length to median sinus 61, to tip of rostrum 65, width 69.3, length of arm 105, of propodus 113, of dactylus 48.8, length of first ambulatory about 235 mm., greatest span 2 feet 4 inches. The largest specimen is a male, station 4083, which has a paper shell and is badly broken. Length of arm 140, of propodus 149, of dactylus 67, span 3 feet.

Color.—Note by collector on male, station 3817: "Pale pink on sides and posterior portion of carapace, becoming salmon pink on anterior part of carapace and on two anterior pairs of legs; three posterior pairs lighter, almost white; eyes lustrous gray."

Note by collector, station 3984: "Female, pale madder pink shading to yellow ocher on dorsum of legs. Abdomen white. Male, pale yellow ocher."

Distribution.—Kaiwi Channel, 298 to 447 fathoms, stations 3470 (type locality), 3473, 3474, 3475, 3476, and 4112; south coast of Oahu Island, 220 to 337 fathoms, stations 3817, 3911, 3916, and 3919; northwest coast of Oahu Island, 241 to 282 fathoms, stations 4116 and 4117; southwest coast of Oahu

Fig. 34.—*Cyrtomaia smithi*, female type, reduced.

Island, 352 to 357 fathoms, station 4123; south coast of Molokai Island, 222 to 498 fathoms, stations 3824 and 3839; north coast of Molokai Island, 328 to 414 fathoms, station 3892; Pailolo Channel, 256 to 684 fathoms, stations 3865, 3867, 3868, 3883, and 3884; northeast approach to Pailolo Channel, 272 to

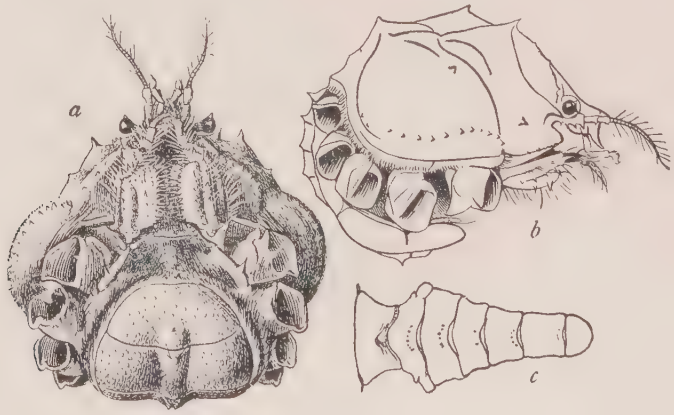

Fig. 35.—*Cyrtomaia smithi*. *a*, Ventral view of female, Cat. No. 17518, × $\frac{7}{10}$. *b*, Side view of same. *c*, Abdomen of male, station 3984, × $\frac{3}{4}$.

286 fathoms, stations 4096 and 4097; vicinity of Modu Manu, 222 to 800 fathoms, stations 3979 and 4166; vicinity of Kauai Island, 55 to 478 fathoms, stations 3984, 3986, 3998, 4022, 4028, 4130, 4131, and 4132; north coast of Maui Island, 238 to 267 fathoms, stations 4083 and 4084.

Cyrtomaia lamellata, sp. nov.

A small species. Resembles much the preceding. Carapace wider. Spines of carapace long, as in *C. smithi* of equal size, not as in *C. smithi* adult; thirteen long spines, three gastric, two cardiac, two branchial (one behind the other), one exorbital, one marginal hepatic; a row of short spines just below the epimeral suture and a short row subparallel and above it.

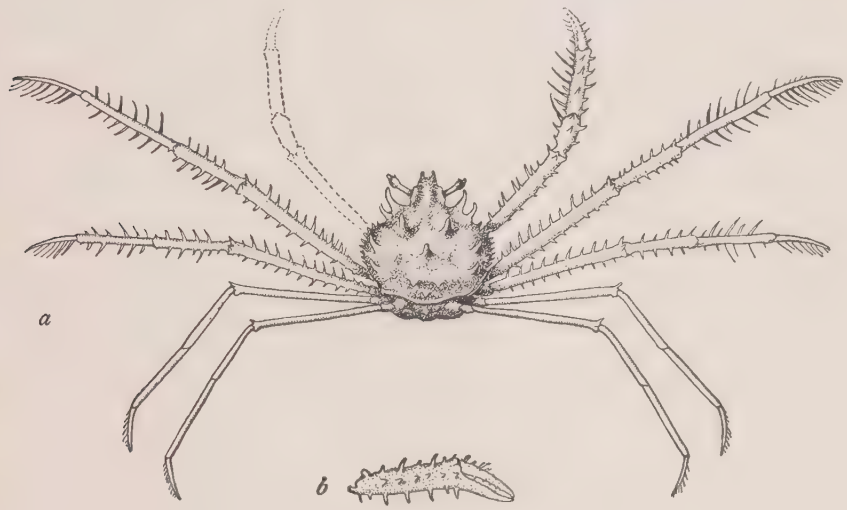

FIG. 36.—*Cyrtomaia lamellata.* *a*, Female, station 3838, × 1⅔. *b*, Chela of male, station 4046, × 1⅔.

Rostral spines very short; the median subrostral projection thin, laminar, upper surface longitudinally concave, tip broken off in all our specimens. Upper margin of orbit much thickened. Eyestalks longer and slenderer than in the preceding. Basal antennal joint armed with three laminar branching spines; next two joints laminately expanded in three directions.

Chelipeds and legs much as in young of *C. smithi.*

Dimensions.—Male, station 4046, approximate length to median sinus 13, width 13.8 mm. Ovigerous female, station 3838, length to median sinus 13.1, width 12.7 mm.

Distribution.—South coast of Molokai Island, 92 to 212 fathoms, station 3838 (type locality); west coast of Hawaii Island, 147 to 71 fathoms, station 4046; northeast coast of Hawaii Island, 83 to 113 fathoms, station 4062. Cat. No. of type, 29701.

The presence of two branchial spines and absence of a supraorbital spine easily separates the species from *C. smithi.*

Oncinopus aranea (de Haan).

Oncinopus aranea Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 183, and synonymy.

Ocinopus aranea Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 685, text fig. 123, 1903.

Distribution.—Vicinity of Kauai Island, 68 to 179 fathoms, station 4128; vicinity of Modu Manu, 33 to 71 fathoms, stations 4149 and 4164.

Sphenocarcinus carbunculus, sp. nov.

(Pl. XIV, fig. 6.)

Posterior two-thirds of carapace covered with nine large raised, button-like protuberances, regularly disposed, three median, on the gastric, cardiac, and intestinal regions, and three on each branchial region, of which one is at the postero-lateral angle of the carapace; these buttons are a little convex above, constricted below, and of a crimson red color except near the edge, which is whitish. A similar protuberance is on the side of the hepatic region, its anterior end being hollowed out inwardly to form a postocular cup. On the gastric region are three tubercles arranged in a triangle base backward.

Rostrum divided nearly to its base; horns about one-fourth or one-fifth the length of the remainder of the carapace, slender, straight, moderately deflexed and divergent.

Supraocular eave moderately swollen, its anterior end not prominent.

Chelipeds of male a little stouter than legs and nearly as long as carapace; those of female no stouter than legs, and a little shorter than carapace minus rostrum; surface smooth; fingers narrowly gaping in both sexes.

Ambulatory legs slender, unarmed except for a spinule at the end of the merus.

The entire surface of the crab except the fingers is covered with a short dense coat of vesicular pubescence, which is thinner and more easily rubbed off from the top of the buttons. There are also long slender hairs except on the elevations.

Dimensions.—Female, type, median length 12.3, including horns 14.7, width 10.4 mm.; male, station 4081, median length 11.1, including horns 14, width 9 mm.

Distribution.—South coast of Molokai Island, 169 to 182 fathoms, station 3835 (type locality); west coast of Hawaii Island, 198 to 147 fathoms, station 4045; north coast of Maui Island, 143 to 220 fathoms, stations 4079, 4080, and 4081; northwest coast of Oahu Island, 195 to 241 fathoms, station 4115. Cat. No. of type, 29798.

This species in its horns and orbits approaches *S. stimpsoni* (Miers), from which the difference in the excrescences will readily separate it, and should the genus *Oxypleurodon* Miers be maintained apart from *Sphenocarcinus*, our species should belong to the former. The orbits are truly Pisine, there being a deepish sinus above, between the supraocular eave and the postorbital cup; the inferior sinus is as deep as, but much narrower than, in *S. stimpsoni* (see Miers, Challenger Brachyura, pl. VI, fig. 1 *b*).

Huenia proteus (de Haan).

Huenia proteus Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 195, and synonymy. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 686, text fig. 124, pl. XLVII, figs. 1 and 2, 1903.

Distribution.—South coast of Molokai Island, 73 to 43 fathoms, station 3849; Auau Channel, 43 to 32 fathoms, station 3872; vicinity of Laysan Island, 10 to 30 fathoms, stations 3955 and 3959; French Frigate Shoal, 14½ to 17½ fathoms, stations 3968, 3969, and 3970; vicinity of Modu Manu, 20 to 183 fathoms, stations 4146, 4158, 4161, and 4164. Hawaiian Islands, A. Garrett, 1 female, in Museum of Comparative Zoology.

Simocarcinus simplex (Dana).

Simocarcinus simplex Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 196, and synonymy.

Hilo, H. W. Henshaw; Honolulu Reef; Waikiki Beach; Laysan; Hawaiian Islands, W. H. Pease, in Philadelphia Academy of Natural Sciences.

FIG. 37.—*Echinœcus pentagonus*, male, station 4147, × 1⅛.

Oahu or Maui (Dana). Honolulu (Cano).

A lobule is present at either extremity of the posterior border of the carapace. The tip of the rostrum sometimes shows signs of bifurcation.

Echinœcus pentagonus Rathbun.

Echinœcus pentagonus Rathbun, Proc. U. S. Nat. Mus., XVII, 1894, 66.

Vicinity of Modu Manu, 26 fathoms, station 4147; 1 male.

Male of same shape as female, anterior portion less deflexed; rostrum not emarginate; length 10.2, width 9.4 mm.

Menæthius monoceros (Latreille).

Menæthius monoceros Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 197, and synonymy. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 1903, 686.

Distribution.—Vicinity of Laysan Island, 10 to 16 fathoms, stations 3959 and 3962; French Frigate Shoal, 14½ to 16½ fathoms, station 3968; vicinity of Modu Manu, 21 to 46 fathoms, stations 3978 and 4162; Honolulu, 1901; reef in front of Honolulu, 1901; east and west coasts of Maui, A. Garrett, in Museum of Comparative Zoology.

Lahaina, Maui (Dana).

Acanthonyx simplex Dana.

Acanthonyx simplex Dana, Crust. U. S. Expl. Exped., I, 126, 1852; pl. v, fig. 4 *a–d*, 1855.

Hawaiian Islands (Dana).

Halimus hilgendorfi (de Man).

Hyastenus hilgendorfii Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 209, and synonymy.

Vicinity of Laysan Island, 16 fathoms, station 3962; one female bearing eggs. Total length, with horns, 14 mm.

The marginal hepatic projection is larger than represented by de Man. The submarginal tubercles, said to be behind the one which lies above the base of the cheliped, are not developed.

A young specimen is also in the collection without label of station.

Halimus tenuicornis (Pocock).

Halimus tenuicornis Rathbun, Bull. Mus. Comp. Zool., XXXIX, 1902, 133, and synonymy. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 687, 1903.

On the upper margin of the orbit, between the supraocular eave and postocular lobe, there is a small spine which is larger in smaller specimens.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 43 to 32 fathoms, station 3872; vicinity of Laysan Island, 10 to 163 fathoms, stations 3936, 3939, 3940, 3955, 3959, and 3962; French Frigate Shoal, 14½ to 16½ fathoms, station 3968; vicinity of Modu Manu, 32 to 46 fathoms, station 3978; vicinity of Kauai Island, 68 to 179 fathoms, station 4128; vicinity of Modu Manu, 20 to 71 fathoms, stations 4146, 4149, 4158, 4159, and 4171.

Halimus ovatus (Dana).

Lahaina ovata Dana, Crust. U. S. Expl. Exped., I, 93, 1852; pl. II, fig. 1 *a–f*, 1855.

Lahaina, Maui (Dana).

Perinea tumida Dana.

Perinea tumida Dana, Crust. U. S. Expl. Exped., I, 114, 1852; pl. IV, fig. 1 *a–f*, 1855.

Distribution.—Kailua; Honolulu; Laysan.

Lahaina, Maui (Dana). Hawaii (Stimpson); one specimen labeled "Sandwich Islands, N. Pac. Expl. Exped." in Museum of Comparative Zoology.

The upper margin of the orbit is not so deeply hollowed out as in Dana's figure and the tubercle either side of the cardiac region is larger.

Chlorinoides goldsboroughi, sp. nov.

(Pl. XIV, fig. 7.)

Surface granulous; two median gastric spines, one intestinal, two cardiac side by side, two large branchial, one of which is much further in and a little behind the other; the outermost, which marks the postero-lateral angle, has a smaller spine in front of it; two flattened lobes on margins of hepatic and branchial regions.

Rostral horns about one-third as long as post-frontal portion of carapace. Supra-ocular eave with a subtruncate tooth at anterior and posterior angles, the latter less advanced than postocular spine; intermediate spine long.

Basal antennal joint with lateral margins very prominent, each terminating in a slender spine, otherwise unarmed.

Chelipeds of male nearly one and one-half times total length of carapace, stout; crests of arm and wrist irregularly dentate, a spine at distal end of arm; chelipeds of female very slender and only as long as postrostral portion of carapace.

Legs decreasing rapidly in length, first pair in male as long as cheliped less half of fingers, in female exceeding cheliped; meral, carpal, and propodal joints spinulous above, the meral joints each with three spines at distal end.

Dimensions.—Male, station 3859, length to median sinus 12.5, to tip of horns 16.4, width without spines 9.3 mm.

Distribution.—South coast of Molokai Island, 134 to 130 fathoms, station 3854; Pailolo Channel, 127 to 148 fathoms, stations 3856, 3859 (type locality), and 3886. Cat. No. of type, 29699.

In the arrangement of the dorsal spines this species resembles *C. spatulifer* (Haswell), but in the latter the spines of the posterior half are spatuliform, the supraocular eave is more projecting, the horns more spreading.

Named for Mr. E. L. Goldsborough, one of the Fish Commission collectors on the Hawaiian expedition of 1901.

With regard to *Chlorinoides* Haswell, 1880, vs. *Acanthophrys* A. Milne Edwards, 1865, both Alcock (Jour. Asiat. Soc. Bengal, LXIV, 1895, 241) and Miers (Challenger Brachyura, 52, 1886) have overlooked the fact that Miers himself designated the type of *Acanthophrys* (Jour. Linn. Soc. London, XIV, 1879, 657) as *A. cristimanus* A. Milne Edwards; the type therefore can not be changed and the important point yet to be determined is, not whether *C. tenuirostris* Haswell (the type of *Chlorinoides*) is congeneric with *A. aculeatus* A. Milne Edwards, but whether it is congeneric with *A. cristimanus* A. Milne Edwards. If this proves to be the case, then the name *Acanthophrys* must take the place of *Chlorinoides*.

Schizophrys hilensis, sp. nov.

A smaller species than *S. aspera*. Surface hairy except the chelipeds, which are nearly naked. Carapace nongranulous, punctate; three gastric spinules in a narrow triangle, base forward; two cardiac tubercles side by side; a short intestinal spine; a branchial spinule on either side of it; two longer spines on posterior margin, either side of middle; five spines forming a marginal curve on each side, the first hepatic.

FIG. 38.—*Schizophrys hilensis*, female type, × 1⅔.

No accessory spines on rostrum; horns straight, sharp, one-sixth as long as postfrontal portion of carapace.

Supraocular eave thick, its posterior angle projecting as an acute tooth; postocular spine simple, broad at base; intermediate spine long.

Chelipeds smooth. Meral joints of legs ending in a sharp tubercle.

Otherwise much as in *S. aspera*.

Length of largest specimen, a female, on median line 17.3, length to tip of horns 19.8, width without spines 12.8 mm.

Hilo, Hawaii, H. W. Henshaw, 1 male, 4 females, types (Cat. No. 29794). West coast of Maui, A. Garrett, October 27, 1859, in Museum of Comparative Zoology. Hawaiian Islands, A. Garrett, April 25, 1860, in Museum of Comparative Zoology.

Ophthalmias[a] **cervicornis** (Herbst).

Stenocenops cervicornis Cano, Boll. Soc. Nat. Napoli (1), III, 1889, 102 and 177.
Stenocionops cervicornis Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 248.

Honolulu (Cano).

Micippa philyra (Herbst).

Micippa hirtipes Dana, Crust. U. S. Expl. Exped., I, 90, 1852; pl. 1, fig. 4 *a–e*, 1855.
Micippa philyra Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 249, and synonymy.

Oahu, H. Mann, 1864, in Museum of Comparative Zoology.

[a] *Ophthalmias* Rathbun, Proc. Biol. Soc. Washington, XI, 1897, 157.

Micippa parca Alcock.

Micippa margaritifera var. *parca* Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 253; Illus. Zool. Investigator, Pt. VI, pl. xxxv, fig. 4, 1898.

Micippa parca Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 1903, 689.

Distribution.—French Frigate Shoal, 14½ to 17½ fathoms, stations 3968, 3970, and 3971; vicinity of Modu Manu, 23 to 26 fathoms, station 4146.

In our specimens the superior fissures of the orbit are more V-shaped than in the figure cited, the outer margin of the hepatic region more pronouncedly spinulous, the lower part of the front broader, being twice as wide as its height below the attachment of the basal joint of the antenna.

Family PARTHENOPIDÆ.

Parthenope (Platylambrus) nummifera, sp. nov.

(Pl. xiv, fig. 4.)

Surface pubescent. Widest part of carapace in line with the anterior margin of the cardiac region. A hollow at the posterior corners of the mesogastric region and another between hepatic and branchial regions. Surface covered, but not closely, with tubercles of variable size which are somewhat mushroomlike, the stalks very short and thick, tops very finely and densely granulate; intermediate space more sparingly granulate; of these tubercles the largest are one median gastric, one median cardiac, a cluster on the anterior elevated portion of the branchial regions. Spines of surface granulated, blunt, not long, disposed as follows: One at rear end of the branchial region, one median at rear end of cardiac region; one marginal hepatic, a row of about six on the antero-lateral margin of the branchial region of which the posterior is the larger; between it and the dorsal branchial spine a row of two or three small but elevated tubercles; a spine on postero-lateral margin at end of broad depression which separates cardiac from elevated part of branchial region; from this spine a row of tubercles running along the depression. A row of small tubercles on posterior margin, the end one largest.

Beak small, prominent, trifid; upper margin of antennulary cavities spinulous. Upper orbital border very thick, a large forward-projecting tubercle; edge crenulate.

Chelipeds of male 3¾, of female 2¾ times as long as carapace, covered with tubercles like those of the carapace, margins armed with very short stout spines or pointed tubercles, arms bluntly angular. In both sexes, the hands are notably unequal in stoutness, the fingers of the larger one widely gaping.

Legs very slender, armed with small stout spines.

Dimensions.—Male type, length 15.2, width 16.7, length of larger cheliped 55.5 mm.

Distribution.—South coast of Oahu Island, 51 to 238 fathoms, stations 3809 and 3811; south coast of Molokai Island, 23 to 212 fathoms, stations 3838, 3845, 3846, and 3847; north coast of Molokai Island, 66 to 96 fathoms, station 3906; vicinity of Kauai Island, 50 to 296 fathoms, stations 3987 and 3991; northeast coast of Hawaii Island, 63 to 113 fathoms, stations 4062 (type locality) and 4064; Aleunihana Channel, 49 to 176 fathoms, station 4066; vicinity of Modu Manu, 71 to 160 fathoms, station 4150. Cat. No. of type, 29826.

Variations.—The single specimen from station 3811 is a well-marked variety. All the spines are sharper and more prominent than in the typical form, and in place of the larger tubercles on the carapace of the latter there are sharp-pointed spines, as one on summit of gastric, of cardiac and of branchial regions.

In many examples the tubercles of the branchial elevation are more or less run together, forming large blister-like patches.

Near *P.* (*P.*) *echinata* (Herbst)[a] (pl. xv, fig. 8) of which a specimen from the Orissa coast has been kindly sent me by Major Alcock. Our species is smaller and narrower, genital region depressed, interspaces between elevations more granulated, chelipeds and legs longer, lower margin of distal end of larger cheliped convex. In *P. echinata* the median spine on the genital region is as elevated as the two on the gastric and cardiac regions.

Also very nearly related to *P. verrucosa* (Studer) (Abh. K. Akad. Wiss. Berlin, 1882, 9, pl. 1, fig. 2 *a–b*, 1883) which has fewer and larger tubercles on carapace and chelipeds, and less flattened and smoother legs.

[a] See *Lambrus* (*Platylambrus*) *echinatus* Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 264, and synonymy.

Parthenope (Platylambrus) stellata, sp. nov.

(Pl. xv, figs. 1, 2, and 7.)

Carapace subtriangular, one and a half times as broad as long. A shallow post-hepatic constriction. Surface of carapace and chelipeds covered everywhere with flattened stellar granules, varying in size and densely placed. Branchio-cardiac and branchio-hepatic depressions not very deep. Protuberances surmounted by á tubercle disposed as follows: Three gastric in a triangle base forward, two median cardiac, the anterior much the more prominent, two branchial, the posterior on postero-lateral margin and both in line with one at end of posterior margin.

Front narrow, tip tuberculiform. The outer angle of the antennulary fossette is a projecting tooth.

A small, blunt spine near posterior end of hepatic margin. Thirteen or fourteen similar spines on antero-lateral margin of branchial region, the last of which forms the lateral angle; near it, on the transverse portion of the postero-lateral margin, two or three spines.

Chelipeds massive, in the male three times as long as carapace; surface nodular; arm obscurely prismatic, margins armed with short, granulated spines, those of the posterior margin the larger, the row being continued proximally on the upper surface. One chela a little stouter than the other, marginal protuberances very nodular and irregular, the largest near middle of inner margin. Fingers of larger chela gaping. In the type the pollex of the smaller claw is entirely lacking, the propodus being truncate at the distal end, with the lower corner smoothly rounded.

Legs very rough, with spinulous borders and surface sharply granulate; lower surface of all the legs and upper surface of merus of the first to third pairs relatively smooth. Distal two-thirds of propodus and basal half of dactylus clothed with long, coarse hair.

Variations.—The above description applies to the type specimen only. A smaller male (station 4045) shows the tubercles and spines all sharp instead of blunt pointed, and lacks the hair near the ends of the legs.

Five of the other six specimens are so different from the type as almost to be declared an independent species. They may be known as *P.* (*P.*) *stellata lacunosa*. The branchio-cardiac depression is deep, and another depression runs along the outer side of the branchial region, adjacent to the marginal teeth. The elevated part of this region has a row of large pits through its middle, and similar lines of pits dividing the gastric region in three and roughening the chelipeds. The granules are in large part confluent and thus obliterated, especially on the higher parts of the carapace and the chelipeds. The legs have smooth surfaces, thin cristate margins which are somewhat crenate or dentate in the merus and are destitute of long hair. Along with two of this variety from station 4100 is one which is intermediate between the typical and varietal form, the stellate granules being everywhere fairly well shown, and also the lines of pits.

Still a third form seems worthy of a distinguishing name, *P.* (*P.*) *stellata complanata*. It differs from the type in the surface of carapace and chelipeds being smooth to the naked eye, though under the lens finely punctate and roughened; the elevations which in the other forms are crowned with a tubercle or spine are here low and smoothly rounded; the tubercle or spine at the inner third of the postero-lateral margin is represented by a triangular nodule; tubercle at each end of posterior margin large and round; antero-lateral teeth broader and more dentiform than in other forms; no teeth nor spines at outer end of postero-lateral margin, but a nodule on the dorsal surface at that point may represent them; marginal spines of chelipeds inclining to sharp; legs approaching the type in roughness; margins prominently spinate, without long hair.

Distribution.—South coast of Oahu Island, 238 to 52 fathoms, station 3811 (type locality), 1 male (Cat. No. 29839); south coast of Molokai Island, 169 to 182 fathoms, station 3835, 1 female *lacunosa;* west coast of Hawaii Island, 198 to 147 fathoms, station 4045, 1 male *lacunosa* type (Cat. No. 29842), 1 male sharp-spined variety; Pailolo channel, 130 to 151 fathoms, station 4100, 2 male *lacunosa*, 1 male intermediate; northwest coast of Oahu Island, 154 to 195 fathoms, station 4114, 1 small female *lacunosa;* vicinity of Kauai Island, 257 to 312 fathoms, station 4132, 2 male *complanata*, type (Cat. No. 29845).

This species can be told at once by its very broad form, stellate granulation, and in the variety by the lines of pits.

The type specimen has several stalked barnacles attached and also a worm tube adherent to the whole length of outer surface of right or larger cheliped. A much smaller individual from station 4045 representing the sharp-spined variety has also a barnacle on the carapace.

Parthenope (Rhinolambrus) lamelligera (White).

(Pl. XVII, fig. 1.)

Lambrus lamelliger White, List Crust. Brit. Mus., 12, 1847 (nomen nudum); Proc. Zool. Soc. London, XV, 1847, 58. Miers, Ann. Mag. Nat. Hist. (5), V, 1880, 230; Challenger Rept., Zool., XVII, 1886, 93 (*?L. rumphii* Bleeker).

Lambrus lamellifrons Adams & White, Voy. Samarang, Crust., 26, pl. v, fig. 1, 1848.

Carapace with rostrum a little longer than broad, its surface covered, though not closely, with granulated tubercles and cylindrical blunt spines. Five median spines, one gastric, three cardiac, one posterior marginal; two side by side on gastric in front of median; one large branchial spine forming the middle one of a longitudinal curve of three; on antero-lateral margin of branchial region a row of about eight small spines. Hepatic region prominent, with one noticeably long spine. Orbital region prominent, carapace distinctly constricted behind it. A spine on dorsal surface of each supraocular eave. Rostrum strongly deflexed, narrow, armed with two or three small spines on each side.

Chelipeds in adult female from two to two and two-fifths times as long as carapace; covered with sharp and granulated tubercles, and on the margins rough triangular spines. Anterior or inner margin of arm with about five long spines and at the distal end three or four smaller ones; above a row of about eight very uneven spines and on the outer margin two or three large ones. On inner margin of hand about six large spines, on outer margin five to seven large ones, and two or more on upper surface. Spines of lower margin of cheliped small, but fairly uniform and very jagged.

Legs almost smooth, armed only with a few rough tubercles; transversely banded in two colors.

There are only two large specimens (females) in the collection; the largest, which is laden with eggs, has the prominent spines much less developed—that is, lower, blunter, and more tuberculiform than in the specimen slightly smaller. The largest male is 14 mm. long, and its chelipeds are just as long in proportion to the carapace as in the adult female. Small specimens are much smoother than large ones, one the same size as that shown by Adams and White (loc. cit.) agreeing very well with the figure.

Dimensions.—Female, station 3861, length 51.2, width 49.5 mm.

Distribution.—South coast of Molokai Island, 23 to 66 fathoms, stations 3847 and 3850; Pailolo Channel, 30 to 52 fathoms, station 3861; Auau Channel, 13 to 43 fathoms, stations 3871, 3874, and 3876; vicinity of Kauai Island, 237 to 164 fathoms, station 3984; vicinity of Modu Manu, 23 to 56 fathoms, stations 4146 and 4164.

This species seems not to differ much from *P.* (*R.*) *longispina* Miers. (See Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 266.) The rostrum, however, is narrower and armed along the sides and there is only a single spine on the posterior border in the middle line.

Parthenope (Aulacolambrus) hoplonotus (Adams & White).

Lambrus (*Aulacolambrus*) *hoplonotus* Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 273, and synonymy.

East coast of Maui, A. Garrett, 1 dried specimen, in Museum of Comparative Zoology.

Parthenope (Aulacolambrus) whitei (A. Milne Edwards).

(Pl. XV, fig. 5.)

Lambrus (*Aulacolambrus*) *whitei* Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 274.

South coast of Molokai Island, 23 to 24 fathoms, station 3847; 1 male.

This specimen differs from the figure given by Adams and White (Voy. Samarang, Crust., pl. v, fig. 3) in the following particulars:

The median spines are much lower; the tubercles and granules of the carapace are more numerous; the large lateral spine extends further sideways; on its posterior base are two teeth; the submedian pair of spines on the posterior margin are very much smaller.

Parthenope (Parthenolambrus) calappoides (Adams & White).

(Pl. xv, fig. 6.)

Lambrus (*Parthenolambrus*) *calappoides* Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 275, and synonymy. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., II, 1903, 690.

Distribution.—South coast of Molokai Island, 43 to 66 fathoms, stations 3845, 3846, and 3850; Auau Channel, 28 to 43 fathoms, station 3876; vicinity of Kauai Island, 40 to 233 fathoms, stations 3982, 3987, and 4002; northeast coast of Hawaii Island, 24 to 83 fathoms, station 4061; vicinity of Kauai Island, 68 to 179 fathoms, station 4128; vicinity of Modu Manu, 26 to 56 fathoms, stations 4148 and 4164.

This species, as Alcock has said, is very variable. In most specimens the regions are not carinated nor sharply raised; in some, however, notably those from stations 3982 and 4164, there is a very high nodule on the gastric and on the cardiac region, the branchial region has a rather strong carina, with a tubercle at its middle, the hepatic region is narrowed and thickened and in consequence widely separated from the branchial region, the supraocular lobes are extremely high. Between this form and the typical are gradations, even in individuals from a single station, as 4061.

Another remarkable variety is represented by an ovigerous female from station 4148. This form varies in a different way from the typical, and were it not for the extraordinary diversity which I have found in other species of *Parthenope*, e. g., *P. stellata* and *P. nummifera*, I should describe it as a distinct species. All the margins of the carapace are more spreading, the front is less vertical, the posterior margin forms a more produced lobe, the antero-lateral border is more limb-like, the lateral angles are strongly upcurved. A long gastric and cardiac spine. Surface of carapace and chelipeds crisply granular and margins of the latter sharply dentate. On the proximal half of upper margin of palm a very thin lamellar lobe with crenated edge. In other specimens this lobe is either absent altogether, as in the typical form, or represented by a thick blunt nodule, as in the nodular variety from station 3982 described above.

Daldorfia horrida (Linnæus).

(Pl. xiv, fig. 5.)

Parthenope horrida Alcock, Jour. Asiat. Soc. Bengal, LXIV, 1895, 279, and synonymy.

Distribution.—Auau Channel, 21 to 43 fathoms, stations 3872 and 3874; Hilo, Hawaii, H. W. Henshaw; Oahu, H. Mann, in Museum of Comparative Zoology.

Fig. 39.—*Daldorfia horrida*, Hilo, first ambulatory leg, × 1⅔.

Hawaiian Islands (Randall); one large male, J. K. Townsend, collector, in Philadelphia Academy of Natural Sciences. Laysan Island (Lenz).

In the two larger specimens the teeth of the legs are triangular except on upper margins of merus joints, where, in the male from station 3874, they are scythe-shaped, the point of each scythe touching or overlapping the convexity of the next, so as to leave orbicular interspaces; in the male from Hilo, the "scythes" have two points in opposite directions and the base of the sinuses is denticulate.

The sternal hollow in the largest and smallest male is subtriangular with corners rounded; in the male from station 3874, it is transverse oblong with a shallow median partition. There is also a line of smaller cavities on either side of the male abdomen.

Harrovia truncata, sp. nov.

(Pl. xiv, fig. 8.)

Carapace hexagonal, a little broader than long; elevated portions finely granulate, depressions smooth. Three gastric elevations corresponding to the regional subdivisions; a transverse curved fold or elevation running across the cardiac and part way across the branchial region; smaller and lower nodules on the anterior branchial and hepatic areas.

Front slightly deflexed, truncate, divided into two feebly concave and oblique lobes by a small notch, and separated by a faint groove from the inconspicuous orbital angle; edge double, granulate. Two teeth of moderate size at lateral angle; at posterior base of the last one a much smaller tooth; a notch at middle of postero-lateral margin which is thick and coarsely granulate. A single line of granules on posterior margin.

Endostome with longitudinal ridges. Inflected portion of carapace and margin of maxilliped furnished with club-shaped setæ.

Only one cheliped, the right, present, shorter and more cancroid than in other species; length about one and a half times that of carapace; surface granular; a broad tooth on upper and lower margins of arm near distal end; a triangular tooth at inner angle of wrist, outer face rough. Palm as high as its superior length, ridged longitudinally inside and out, there being four ridges outside, between upper and lower margins. Fingers stout, grooved, fitting close together.

FIG. 40.—*Harrovia truncata*, chela of type male, × 4⅔.

Legs compressed, with sharp, cristiform borders; two teeth on upper border of carpal, one on same border of propodal joints; last three joints hairy below.

The single specimen, a male, is immature.

Dimensions.—Male, length 5.5, width 6.5 mm.

Type locality.—Vicinity of Kauai Island, 233 to 40 fathoms, station 3982, 1 male (Cat. No. 29804).

This species is distinguished by the absence of a supraorbital tooth, the short chelipeds and dentate carpal and propodal joints of legs.

Family CALAPPIDÆ.

Calappa calappa (Linnæus).

Calappa fornicata Alcock, Jour. Asiat. Soc. Bengal, LXV, 1896, 142, and synonymy.

Honolulu; Honolulu market; Oahu, H. Mann, in Museum of Comparative Zoology.

Calappa hepatica (Linnæus). Native name, *Papaki* (Owen).

Calappa hepatica Alcock, Jour. Asiat. Soc. Bengal, LXV, 1896, 142, and synonymy.

Honolulu; Honolulu reef; Honolulu market; Hilo.

Hawaiian Islands (Randall, Eydoux & Souleyet, Dana, Streets); 5 specimens collected by T. Nuttall and J. K. Townsend, in Philadelphia Academy of Natural Sciences. Oahu (Owen). Honolulu reefs (Miers). Pearl Harbor and Laysan (Lenz).

Calappa gallus (Herbst).

Calappa gallus Alcock, Jour. Asiat. Soc. Bengal, LXV, 1896, 146, and synonymy.

Hilo, in little tidal pool, and Keaukaha, Hawaii, H. W. Henshaw; Kauai, A. Garrett, in Museum of Comparative Zoology; northeast coast of Hawaii, 24 to 83 fathoms, station 4061; south coast of Molokai, 43 to 66 fathoms, station 3850; vicinity of Modu Manu, 30 to 31 fathoms, station 4159.

Maui (Dana).

Note on color of male, station 4061: "Carapace and chelipeds mottled yellowish, reddish, and grayish brown; under surface mottled yellow and white; legs yellow." Sea green (Henshaw).

Mursia hawaiiensis Rathbun.

(Pl. XVIII, figs. 3 and 4.)

Mursia hawaiiensis Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 252.

Distribution.—Lat. 21° 12′ N., long. 157° 49′ W., 295 fathoms, station 3472 (type locality); south coast of Oahu Island, 53 to 264 fathoms, stations 3810, 3813, and 3919; vicinity of Kauai Island, 164 to 399 fathoms, stations 3984, 4021, and 4130; west coast of Hawaii Island, 233 to 198 fathoms, station 4044; north coast of Maui Island, 178 to 220 fathoms, stations 4080 and 4081; northwest coast of Oahu Island, 154 to 282 fathoms, stations 4114, 4115, 4116, 4120, and 4121; southwest coast of Oahu Island, 192 to 352 fathoms, station 4122.

This species was based on a single male in which the chelipeds are very unequal; a series of specimens shows that the right claw is abnormally reduced; in the normal individual the chelipeds are subequal in size, and similar except as to the fingers. Several examples larger than the type were secured in 1902; the largest, a male, station 4080, measures 40.1 mm. long and 55.2 mm. wide to tips of spines.

Two young, 11 mm. long and less, have proportionally much longer spines, each spine of the carapace being about one-fifth as long as the width of the carapace measured in front of the spine; the arm spine is stouter and as long as or longer than that of the carapace. The two teeth of the posterior margin are longer than in the adult, and the tubercles of the dorsal surface much stronger.

Mursia spinimanus, sp. nov.

(Pl. XVI, fig. 1.)

Closely related to *M. bicristimana* Alcock (conf. Deep-Sea Brachyura Investigator, 23, pl. III, fig. 3). It differs as follows:

The posterior margin is armed with three, instead of two, blunt denticles.

The crest of the arm is three-spined, the innermost very small, the outermost longer than in *M. bicristimana*, and three-fourths as long as the spine of the carapace, in the young fully as long as the latter.

FIG. 41.—*Mursia spinimanus*, station 3856, lower view of orbit and antenna of male, × 2⅔.

Lower margin of hand armed with slender spines directed more obliquely than in *M. curtispina* Miers (Challenger Rept., pl. XXIV, fig. 2). The inner surface has a band of felt-like hair above the lower margin. Thumb longer than in *M. bicristimana*, exceeding its greatest width.

The three lobes of the carina of the second abdominal segment are more nearly equal, the median only slightly wider than the lateral.

In the tridentate posterior margin, spinose inferior margin of hand, and elongate thumb, this species approaches *M. curtispina*, from which it is at once separated by the wider carapace, broader movable finger, and different shape of teeth on upper margin of palm.

Dimensions.—Male type, length 36 mm., width measured just in front of spines 46.1 mm., width between tips of spines 65.7 mm.

Distribution.—South coast of Oahu Island, 52 to 238 fathoms, stations 3810 and 3811; south coast of Molokai Island, 92 to 212 fathoms, stations 3838 and 3855; Pailolo Channel, 123 to 141 fathoms, stations 3856 (type locality) and 4104. Cat. No. of type, 29922.

I agree with Maj. Alcock that *Platymera* should be united with *Mursia*.

Cycloës granulosa de Haan.

Cycloes granulosa de Haan, Fauna Japonica, Crust., p. 71, pl. XIX, fig. 3, 1837.
Cryptosoma granulosum Alcock, Jour. Asiat. Soc. Bengal, LXV, 1896, 152.

Distribution.—South coast of Molokai Island, 43 to 73 fathoms, stations 3846, 3849, and 3850; vicinity of Kauai Island, 50 to 55 fathoms, station 3987.

Family LEUCOSIIDÆ.

Tlos latus Borradaile.

Tlos latus Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., I, pt. 4, 437, text fig. 115, 1903.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; Auau Channel, 32 to 37 fathoms, station 3873.

These specimens are a little smaller than the type; the immature female shows the unevenness of the surface more distinctly than the mature female. Length of the latter 3.7 mm., width 5.6 mm.

Tlos angulatus, sp. nov.

(Pl. xvi, fig. 5.)

Near *T. latus* Borradaile, but larger and with more angular outline; granulation close and fine over the main part of the carapace, much coarser on the borders. The branchial humps are higher, the pterygostomian and intestinal humps more prominent, while the carapace is pronouncedly wider at the anterior of the lateral angles than at the posterior. The hand from the outside is broader at base and the immovable finger slenderer.

Dimensions.—Length of type female 7.8 mm., width 11.5 mm.

Distribution.—Vicinity of Kauai Island, 50 to 55 fathoms, station 3987 (type locality); Aleunihana Channel, 49 to 176 fathoms, station 4066. Cat. No. of type, 29854.

Fig. 42.—*Tlos angulatus*, type female. *a*, Dorsal view, × 1⅔. *b*, Chela, × 2⅔.

Ebalia tuberculosa (A. Milne Edwards).

Persephona tuberculosa A. Milne Edwards, Jour. Mus. Godeffroy, IV, 1873, 86 [10].

Ebalia tuberculosa Miers, Challenger Rept., Zool., XVII, 305 and 306, pl. xxv, fig. 1, 1886.

Distribution.—South coast of Oahu Island, 211 to 53 fathoms, station 3810; south coast of Molokai Island, 92 to 212 fathoms, stations 3835, 3838 and 3855; Pailolo Channel, 30 to 52 fathoms, station 3861; west coast of Hawaii Island, 198 to 147 fathoms, station 4045.

The largest specimens taken are about the size of the type; but most of them are smaller, averaging about 4 mm. Numerous examples were obtained by means of the tangles at stations 3835 and 4045.

Ebalia jordani, sp. nov.

(Pl. xv, fig. 3.)

Carapace suborbicular, a little longer than broad in the male, a little broader than long in the female. Surface of body and legs finely and closely granulate. Regions distinctly separated by grooves. A median ridge from the front to the intestinal region; a conspicuous gastric tubercule either side of the middle. A large hump marks the inner portion of each branchial region; on its summit three minor swellings can be made out. Two cardiac tubercles, the anterior the higher. Intestinal region much swollen and also partially divided into an anterior and a posterior swelling. Posterior margin prominent, bilobed. A small pterygostomian tubercle visible on antero-lateral margin. Behind hepatic region a broad but distinct emargination. Sometimes a small tubercle on margin at widest point. Front feebly bilobed, lobes truncate, outer angles rounded.

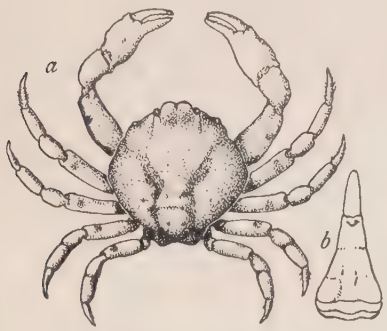

Fig. 43.—*Ebalia jordani*, type male. *a*, Dorsal view, × 1⅔. *b*, Abdomen, × 2⅔.

Palm swollen, about same length as dactylus. Terminal segment of male abdomen oblong-linear, a sharp tooth just behind it.

Named for Dr. D. S. Jordan, leader of the Hawaiian expedition, 1901.

Dimensions.—Length of male type 11.4 mm., width 11.2 mm., length of female (station 3857), 13 mm., width 13.8 mm.

Distribution.—South coast of Oahu Island, 211 to 53 fathoms, station 3810; south coast of Molokai Island, 130 to 127 fathoms, station 3855 (type locality); Pailolo Channel, 30 to 128 fathoms, stations 3856, 3857, and 3861. Cat. No. of type, 29865.

Nucia speciosa Dana.

Nucia speciosa Dana, Crust. U. S. Exped., I, 397, 1852; pl. xxv, fig. 5, 1855.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; vicinity of Laysan Island, 163 to 59 fathoms, station 3939.

Length of ovigerous female 4.3 mm., width 5.2 mm. These specimens are much smaller than the type and the tubercles much less prominent, especially those of postero-lateral margin.

Hawaiian Islands, A. Garrett, in Museum of Comparative Zoology; determined by W. Faxon.

Hawaiian Islands (Dana).

Randallia distincta Rathbun.

(Pl. XVI, figs. 2 and 3.)

Randallia distincta Rathbun, Proc. U. S. Nat. Mus., XVI, 1893, 257.

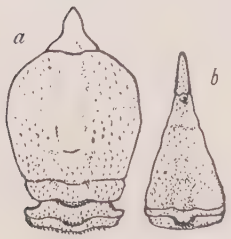

FIG. 44.—*Randallia distincta*, station 4079, × 4/3. *a*, Abdomen of female. *b*, Abdomen of male.

A large number of specimens were taken by the *Albatross* in 1902, but most of them were immature. The few large specimens show somewhat different characters from those possessed by the type, an immature female.

Carapace of adult slightly longer than broad in male; slightly broader than long in female. Granules in male more elevated, but scarcely larger posteriorly than anteriorly; in female larger posteriorly than anteriorly. An ill-defined line of somewhat larger granules marks the lateral margin along the anterior half of the branchial region, but there are no projecting tubercules, as seen in the half-grown individuals. Posterior margin truncate, without the teeth which exist in the young; no spine on intestinal region; only a low tubercle. Pterygostomian region with rounded margin without tubercle.

Chelipeds in male two and a third times as long as carapace; in female slightly more than twice as long as carapace.

Abdomen of male narrow-triangular, granulous at base, a broad tubercle at end of penultimate segment, and two lower tubercles at end of the antepenultimate. Terminal segment almost linear. Terminal segment in female triangular with concave sides.

Dimensions.—Male, station 4044, length 43, width 41.5 mm.; female, station 4079, length 39.6, width 40 mm.

The smallest specimen with a tubercle on the intestinal region is an immature female, station 4115, 29.5 mm. long, while the largest specimen with a spine is also a female, station 4082, 32.2 mm. long. Both present two low blunt posterior teeth, and rudimentary tubercles on the branchial margin. In none of the examples of intermediate size is the intestinal spine partially developed; when present at all it is a strong recurved spine.

Distribution.—South coast of Oahu Island, 183 to 295 fathoms, stations 3813, 3818, and 3920; northwest coast of Oahu Island, 195 to 282 fathoms, stations 4115, 4116, 4117; southwest coast of Oahu Island, 192 to 352 fathoms, station 4122; south coast of Molokai Island, 238 to 266 fathoms, stations 3836 and 3839; Pailolo Channel, 256 to 284 fathoms, stations 3865 and 3883; vicinity of Kauai Island, 235 to 228 fathoms, station 3998; west coast of Hawaii Island, 233 to 198 fathoms, station 4044; north coast of Maui Island, 143 to 238 fathoms, stations 4079 and 4082.

Randallia gilberti, sp. nov.

(Pl. XVI, fig. 4.)

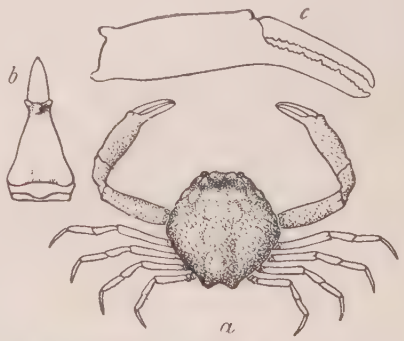

FIG. 45.—*Randallia gilberti*. *a*, Type female, × 1⅜. *b*, Abdomen of male, station 4062, × 4. *c*, Chela of type female, × 4⅜.

Carapace about as broad as long; surface granulous, granules irregular, smallest on the lobules and on the fronto-orbital region. Anterior half of carapace lobulate. Median carina interrupted by two lobules; on either side five other lobules, three of which are gastric, forming a triangle, and two hepatic. Visible angle of pterygostomian region broadly triangular; marginal sinus between hepatic and branchial regions slight; a few low tubercles on the antero-lateral portion of the latter. Intestinal region swollen, rising to a point in the middle, unarmed. Posterior margin with two lobes separated by a broad sinus. Front with broad shallow emargination.

Chelipeds and legs granulate all over. Chelipeds less than twice as long as carapace; palm longer than fingers. Legs slender.

Spine at end of penult segment of male abdomen relatively long and slender.

Dimensions.—Length of female type 8.8 mm., width 9.1 mm.; length of male, station 3855, 6 mm., width 5.8 mm.

Named for Dr. Charles H. Gilbert of the Hawaiian Expedition, 1902.

Distribution.—South coast of Molokai Island, 130 to 127 fathoms, station 3855; north coast of Molokai Island, 66 to 96 fathoms, station 3906; vicinity of Laysan Island, 163 to 59 fathoms, station 3939 (type locality); northeast coast of Hawaii Island, 83 to 113 fathoms, station 4062; Aleunihana Channel, 176 to 49 fathoms, station 4066. Cat. No. of type, 29869.

Persephona brevimana (Alcock).

Myra brevimana Alcock, Journ. Asiat. Soc. Bengal, LXV, 1896, 206; Illus. Zool. Investigator, Crust., pl. xxix, fig. 8, 1897. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., I, 438, 1903.

Distribution.—Northeast coast of Hawaii Island, 77 to 75 fathoms, station 4057; north coast of Maui Island, 52 to 56 fathoms, station 4071; vicinity of Kauai Island, 68 to 179 fathoms, station 4128.

Length of largest specimen 14.5 mm.

Family DORIPPIDÆ.

Ethusa mascarone hawaiiensis, subsp. nov.

(Pl. xv, fig. 4.)

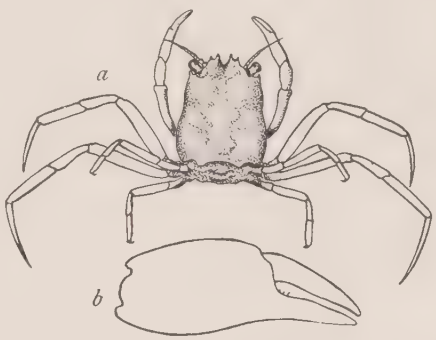

Fig. 46.—*Ethusa mascarone hawaiiensis.* *a*, Type female, × 1⅜. *b*, Larger chela of male, station 4045, × 9⅜.

This form is very near typical *E. mascarone*, yet differs from it in quite another direction than does the *americana* form. The submedian pair of frontal teeth are triangular, not acuminate, and are separated from each other by an emargination which is nearly rectangular at base; the outer pair are small, slender, acuminate, and situated midway on the outer slope of the inner pair. Distance between tips of teeth on one side only about one-third distance between tips of median pair. The outer orbital tooth is smaller than in typical *mascarone* and is directed slightly outward.

There are two lobules side by side on the cardiac region; the propodi of the last two legs are more slender than in the species; the antennary flagellum bears a few hairs. In the only male, which is immature, the fingers of the large chela are longer and slenderer than in the male of the European form.

Distribution.—South coast of Oahu, 211 to 53 fathoms, station 3810; west coast of Hawaii Island, 198 to 147 fathoms, station 4045; Pailolo Channel, 143 to 122 fathoms, station 4101 (type locality). Cat. No. of type, 29930.

Ethusina gracilipes (Miers).

Ethusa (*Ethusina*) *gracilipes* Alcock, Deep-Sea Brach. Investigator, p. 34, 1899, and synonymy.

Distribution.—Pailolo Channel, 284 to 290 fathoms, station 3867; south coast of Oahu, 308 to 322 fathoms, station 3909; vicinity of Kauai Island, 257 to 478 fathoms, stations 4028 and 4132.

These specimens have the spine at the antero-lateral angle of the carapace short, as in Miers's variety *robusta*, but not so strongly bent outward.

Family HAPALOCARCINIDÆ.

Hapalocarcinus marsupialis Stimpson.

Hapalocarcinus marsupialis Stimpson, Proc. Boston Soc. Nat. Hist., VI, 1859, 412. Calman, Trans. Linn. Soc. London (2), VIII, 1900, 43, pl. III, figs. 29–40, and synonymy. Borradaile, Fauna and Geogr. Maldive and Laccadive Arch., I, 271, 1902.

Distribution.—Hilo, Hawaii, 1 fathom (Stimpson); Hawaiian Islands (Verrill); Kailua, August, 1901, one female, without indication of habit.

Forms galls on certain species of branching coral (see Calman).

There is no reference to this species in the manuscript of Stimpson's unpublished report of the Crustacea of the North Pacific Exploring Expedition, but among the illustrations there is a figure of the dorsal aspect of the animal enlarged twice. With reference to the discrepancies in Stimpson's description pointed out by Calman (op. cit., p. 44), it may be said that "antennæ" should be read for "antennules," as the latter are represented of good size in Stimpson's figure. The general appearance of the figure is the same as that of our specimen; the front is truncated and a little concave, and there is no median tooth as represented by Calman.

The female from Kailua has the abdomen filled with eggs; the pouch is much more expanded than shown by Calman (op. cit., fig. 30), being about twice as wide as the carapace, and at the same time extending forward to the middle of the latter. Length of carapace 4,· width 3.8, width of egg-pouch 7 mm.

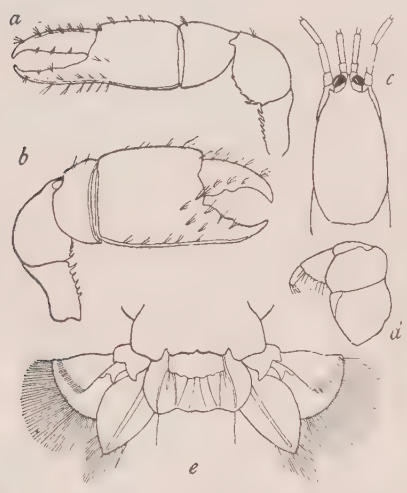

FIG. 47.—*Callianassa articulata*, station 4148. *a*, Left cheliped, × 3⅛. *b*, Right cheliped, × 3⅛. *c*, Anterior portion, × 3⅛. *d*, Third maxilliped, × 8. *e*, Tail-fan, × 4⅛.

MACRURA.

Family CALLIANASSIDÆ.

Callianassa articulata, sp. nov.

Belongs to the group with three long frontal spines and a short telson.

Median rostral spine reaching end of eyes. Lateral spine just outside the eye, much shorter than the median, and articulated at its base.

Telson much broader than long, concave behind, uneven, sparingly setose.

Ophthalmopods not reaching end of first antennular segment, cornea large, hemispherical, occupying more than half length of stalk and reaching to end of it.

Third antennular segment one and a half times as long as second; outer flagellum much thicker and a little shorter than inner one and as long as peduncle.

Antepenult segment of antennal peduncle armed above with a distal terminal spine; last two joints subequal; flagellum twice as long as carapace.

Ischium and merus of outer maxilliped nearly twice as wide as propodus; ischium with an inferior comb of spinules; one spinule on anterior margin of merus.

First pair of chelipeds smooth, very unequal in width, of nearly same length; ischium and merus spined on lower margin. Wrist of larger cheliped more than twice as high as long, a small tooth at lower distal angle. Carpus, propodus, and dactylus margined above and below, and beset along the margins, and on distal portion of palm, as well as on the fingers, with tufts of a few hairs. Palm very little longer than high. Fingers shorter than palm, broad, not gaping, a low tooth near middle of prehensile edge of each, tips crossing.

Carpus of smaller cheliped longer than that of larger, but still higher than long; palm also longer; fingers not dentate.

Dimensions.—Length of carapace, ovigerous female, type, 6.4 mm., of abdomen 16 mm.

Distribution.—Vicinity of Modu Manu, 23 to 33 fathoms, stations 4146 and 4148 (type locality), 1 female at each. Cat. No. of type, 30532.

The lateral movable spine of the anterior margin and the large cornea distinguish this species.

Callianassa, sp.

One specimen of a *Callianassa* was taken on Honolulu Reef, 1902. It is too fragmentary for determination, as it lacks the last four abdominal somites and the right cheliped of the first pair, which was probably the larger. The front has three obtuse teeth and resembles that of *C. amboinensis* de Man (Arch. f. Natur., LIII, pt. 1, 1887, p. 480, pl. xx, fig. 4), but in that species the third joint of the antennula is three times as long as the second, while in our specimen it is only twice the second.

The left cheliped is smooth and unarmed, merus and carpus of equal length, carpus a little longer than broad and a little longer than the palm; fingers slender and subequal to palm, furnished with tufts of hair, tips crossing.

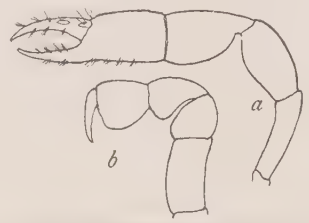

FIG. 48.—*Callianassa*, sp., Honolulu Reef. *a*, Left cheliped, × 3⅛. *b*, Outer maxilliped, × 4.

Family AXIIDÆ.

Axius pailoloensis, sp. nov.

Carapace a little longer than first five segments of abdomen; granulate and pubescent. Rostrum long-pointed, reaching to end of second antennular segment; terminal spine upturned, two pairs of side spines. Gastric region with five carinæ, more or less serrated; median carina two-toothed near its middle; submedian carina not reaching to orbit or to cervical suture, irregularly serrate; between its anterior end and the median carina are two denticles; outer carina a continuation of rostral borders and extending halfway back on gastric region, armed with two spines, the anterior of which, just behind the orbit, is the largest of the dorsal spines.

Abdomen somewhat pubescent; pleura bluntly angular on the posterior half. Telson a little longer than wide, posterior margin convex; in front of this margin on either side are inserted two slender spines; two minute spinules on either side of the dorsal surface.

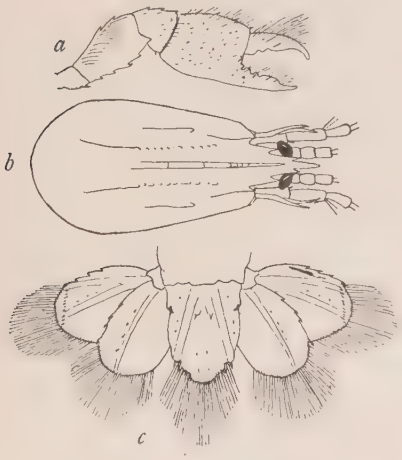

FIG. 49.—*Axius pailoloensis*, type. *a*, Right cheliped, × 1⅝. *b*, Anterior portion, × 4⅛. *c*, Tail-fan, × 3⅛.

Eyes reaching to middle of rostrum, cornea terminal, almost black in alcohol.

Second and third antennular segments subequal; flagella equal, longer than carapace.

Acicular spine of antenna reaching middle of penult segment of peduncle; stylocerite not attaining end of that segment; peduncle exceeding that of antennula by length of last segment; flagellum as long as body.

Outer maxillipeds extended reach beyond antennal peduncle, by length of last segment and half of the penultimate. Lower margin of ischium and merus armed with spinules, with two larger spines on the merus.

Chelipeds equal, stout, upper margin spinulous; the part beyond the body long-hairy; a few long spines on lower border of ischium and merus; carpus higher than long, an infero-distal spinule, a spinule near upper distal angle. Propodus convex and margined below; two spines at distal end of palm, one between bases of fingers, one near upper margin. Palm a little longer than high; horizontal length of fingers equal to height of palm. Fingers irregularly toothed, narrowly gaping at base, tips crossing.

Merus of second and third pairs of feet spinulous below; propodus of second to fifth pairs slender.

Appendages of sixth segment of abdomen armed with a row of four spines on outer margin; a row of four similar spines on carina of inner appendage. Both branches, as well as telson, fringed with long hair.

Dimensions.—Female, length of carapace 11.7, of abdomen 17 mm.

One specimen only was dredged in Pailolo channel, in 138 to 140 fathoms, station 3859 (Cat. No. 30533).

The chelipeds of this species strongly resemble those of *Calastacus felix* Anderson, as does also the anterior part of the carapace.

Axius spinosissimus, sp. nov.

Differs from the preceding, *A. pailoloensis*, as follows:

There is a row of spines along the posterior border of the cervical suture; three spines each side of rostrum; the five gastric carinæ extend the full length of that region and bear numerous spines. In addition there are a hepatic spine and an antennal spine.

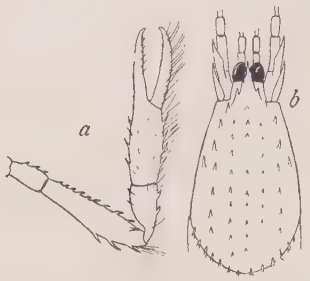

FIG. 50.—*Axius spinosissimus*, type. (*a*) Left cheliped, × 4. *b*, Anterior portion, × 5⅜.

Abdomen marked with short longitudinal impressed lines. Instead of minute spinules there are four spines on middle of telson.

Eyes longer, reaching nearly to end of rostrum.

Lower margin of maxillipeds and thoracic legs more spinose. Besides a series of long spines on ischium and merus of maxilliped, there is a spine on the carpus.

Only the left of the first pair of chelipeds is present. It is very slender, only twice as wide as those of second pair; distal half pubescent; margins spinous, except of fingers and lower edge of wrist; palm and fingers subequal in length, palm more than twice as long as wide; fingers denticulate, not gaping.

Lower margin of ischium and merus of second to fifth pairs of feet spinous; third to fifth pairs very slender. A spine on lower surface of coxal joint of first to fourth pairs.

Dimensions.—Length of carapace 7.5, of abdomen 11 mm.

One specimen from south coast of Molokai Island, 23 to 24 fathoms, station 3847 (Cat. No. 30534).

Axius rudis, sp. nov.

A much less spiny species than the two preceding. The carapace granulate but nearly naked. Rostrum very slender, reaching to end of first antennular segment, armed with three or four spines and spinules on each side, diminishing anteriorly, basal spine large.

Five dorsal carinæ, median unarmed, submedian three-spined, outer carina, a continuation of outer margin of rostrum, unarmed. Median carina longest, outer carina reaching only to middle of gastric region.

First abdominal pleuron narrow, falcate; second to fifth truncate; sixth bluntly angular, with a spinule at the angle, which is obsolete in the large specimen; four dorsal spines on telson; lateral margins spinulous.

Eye half as long as rostrum, cornea large, hemispherical, oblique. Second and third segments of antennæ equal, flagella subequal and as long as the carapace and first three abdominal somites. Scaphocerite rather short, reaching only about one-third length of penult segment of antennal stalk; stylocerite reaching nearly to end of that segment, which is twice as long as last segment; flagellum twice as long as body.

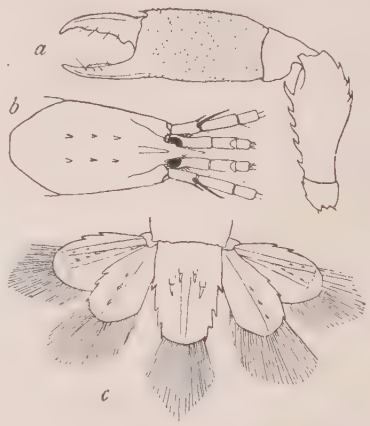

FIG. 51.—*Axius rudis*, type. *a*, Left cheliped, × 3⅜. *b*, Anterior portion, × 4⅛. *c*, Tail-fan, × 4⅛.

First pair of chelipeds unequal, resembling much those of *Eiconaxius coronatus* Trybom.[a] Ischium and merus of larger one spined on lower margin, merus with three spines on distal half of upper margin; carpus cup-shaped, no longer than high; palm about one and a half times as long as high, narrowed a little at proximal end, a denticulated marginal line above, ending in a slender spine; a similar line on part of lower margin continued on the pollex; outer and inner surfaces covered except near the wrist with scaly granules, on a background of very minute granules visible only with a strong lens. Fingers two-thirds as long as palm, sparingly toothed, a large tooth near base of dactylus; gaping, hairy, tips crossing.

Smaller cheliped similar, but much narrower and a little shorter than the larger.

Second pair of legs with long spines on lower margin of merus.

[a] Ark. f. Zool., Stockholm, I, 1904, 384, pl. XX, figs. 7–10.

Outer margin of appendages of sixth abdominal somite, as well as the dorsal carina of the inner branch, armed with spines.

Dimensions.—Female type, length of carapace 8, of abdomen 12 mm.

South coast of Molokai Island, 92 to 212 fathoms, station 3838 (type locality), 1 ovigerous female; vicinity of Kauai Island, 233 to 40 fathoms, station 3982, 2 small males. Cat. No. of type, 30535.

Axius serratifrons A. Milne Edwards.

Axia serratifrons A. Milne Edwards, Jour. Mus. Godeffroy, IV, 1873, 87 [11].

Hawaiian Islands (A. Milne Edwards).

Eiconaxius asper, sp. nov.

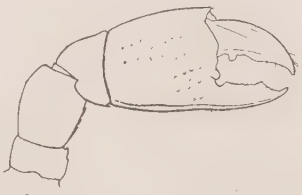

FIG. 52.—*Eiconaxius asper,* station 3992, right cheliped, × 2⅝.

Near *E. acutifrons* Bate, *E. crista-galli* (Faxon) and *E. caribbæus* (Faxon). It resembles the first and differs from the second in the presence of a larger basal tooth on dactylus of larger hand and a more prominent tooth not far from middle of pollex.

Resembles *E. crista-galli* and differs from *E. acutifrons* in having edges of rostrum distinctly denticulate, and median carina denticulate; in the abdominal pleura less sharply pointed; in the entire upper border of the hands, and the presence of a strong tubercle on the anterior border of the larger hand between the bases of the fingers.

The outer and inner surfaces of the manus of both chelipeds are granulate, sparingly, and unevenly, but rather coarsely so, and the palms are higher in proportion to their length than in either of the related species.

E. caribbæus has also an elongate palm and a more rounded rostrum.

Distribution.—Vicinity of Kauai Island, 418 to 528 fathoms, stations 3992 (type locality) and 3997. Found in sponge cavities. Cat. No. of type, 30536.

Color.—Lemon-yellow.

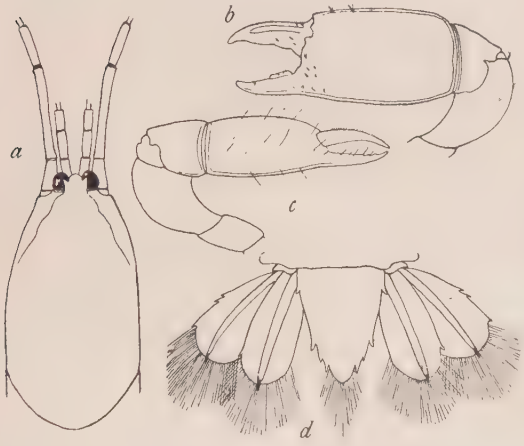

FIG. 53.—*Paraxius tridens,* type. *a,* Anterior portion, × 5⅜. *b,* Left cheliped, × 2⅝. *c,* Right cheliped, × 2⅝. *d,* Tail-fan, × 4⅜.

Paraxius tridens, sp. nov.

Carapace smooth, sloping abruptly down behind the front; a short median carina on the slope. Rostrum triangular, short, barely reaching end of eyes, a tuberculiform tooth either side. The three projections of the rostrum are much sharper in the male, and the lateral teeth form short carinæ.

Abdomen smooth, with scattered hairs; pleura of first segment little developed, of second to fifth segments truncate, of sixth broadly rounded; sides of telson converging, four-spined, tip rounded.

Eye-stalks short, stout; corneæ large, black.

Three joints of antennular peduncle subequal, flagella half as long as carapace.

Antennal peduncle twice as long as the antennular, unarmed; penult segment twice as long as last segment; flagellum as long as body.

Outer maxillipeds stout, exceeding the rostrum by their last three joints; lower margin hairy, two spines on merus.

First pair of chelipeds unequal in width, smooth, unarmed; merus of larger one about one-third longer than high; carpus higher than long; palm one and a half times longer than high, tapering very slightly toward the fingers, rimmed above and below, fringed with long fine hairs; fingers stout, blunt-pointed, not gaping. Narrower cheliped similar; carpus just as long as high; palm twice as long as high; fingers slenderer.

Propodus and carpus of second pair of feet subequal and three-fifths as long as merus; fingers as long as palm, tips dark-colored. Last three pairs subchelate, the propodus being widened at the extremity by an infero-distal spine or tooth, against which the dactylus folds.

First somite of pleon provided with appendages in female only.

Outer branch of swimming-fan with outer margin armed with two or three spinules; no transverse carina near distal end. Inner branch with a terminal spine on outer margin and on longitudinal carina.

Dimensions.—Female, length of carapace 10, of abdomen 14.6 mm.

Distribution.—French Frigate Shoal, 17 to 17½ fathoms, station 3970; vicinity of Modu Manu, 20 to 33 fathoms, stations 4147, 4148 (type locality), 4158, and 4162. Cat. No. of type, 30537.

Family SCYLLARIDÆ.

Scyllarus martensi Pfeffer.

(Pl. XVIII, fig. 2.)

Scyllarus arctus de Haan (second var.), Fauna Japon., 154, pl. XXXVIII, fig. 2, 1841. Not *S. arctus* (L.).
Arctus arctus de Haan, op. cit., 238, 1849 (part).
Scyllarus martensi Pfeffer, Verh. Naturw. Vereins Hamburg-Altona, V, 1880, p. 48 (1881).
Arctus martensi Ortmann, Zool. Jahrb., Syst., VI, 1891, 44; X, 1897, 272.

Distribution.—South coast of Molokai Island, 43 to 66 fathoms, station 3850; Auau Channel, 45 to 32 fathoms, station 3872; vicinity of Kauai Island, 230 to 53 fathoms, station 4002; Japan (de Haan); Kagoshima (Ortmann).

In the Philadelphia Academy of Natural Sciences is the abdomen 80 mm. long of a dried specimen of *Scyllarus*, labeled "Sandwich Islands, T. Nuttall." This is not mentioned in Randall's list (1840). It has the size and sculpture of the European *S. arctus* (L.), and the locality label is probably an error.

Scyllarides squammosus (Milne Edwards).

Scyllarus squammosus Milne Edwards, Hist. Nat. Crust., II, 284, 1837. Mauritius.
Scillarus latus Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 137. Not *Scyllarus latus* Latreille, 1803.
Scyllarus sieboldi de Haan, Fauna Japon., 152, pl. XXXVI and XXXVII, fig. 1, 1841. Nagasaki.
Scyllarus haanii de Siebold, MS., de Haan, Fauna Japon., 152, pl. XXXVIII, fig. 1, 1841.
Scyllarus luridus Stimpson, MS. label in Museum of Comparative Zoology.

The Hawaiian specimens resemble most nearly de Haan's figure of *S. sieboldi; S. haanii* has the elevations of the surface more prominent, and is probably only a variety.

Honolulu; Honolulu market; Honolulu Reef, Dr. W. H. Jones; northeast coast of Hawaii, 29 to 26 fathoms, station 4053.

Hawaiian Islands (Randall), one specimen in Philadelphia Academy of Natural Sciences (vide Ortmann, 1897). Honolulu (Lenz).

Parribacus antarcticus (Lund).

Scyllarus antarcticus Lund, Skrivter af Naturhistorie-Selskabet, Copenhagen, II, 1793, 2, p. 22.
Parribacus antarcticus Dana, Crust. U. S. Expl. Exped., I, 517, 1852; pl. XXXII, fig. 6, 1855.
Ibacus antarcticus Dana, op. cit., p. 517.

Hilo; Honolulu; Honolulu market; Oahu, H. Mann, 1864, in Museum of Comparative Zoology; lee coast of Oahu, A. Garrett, in Museum of Comparative Zoology; Waiawa, Kauai, V. Knudsen.

Hawaiian Islands (Randall, Stimpson); 2 specimens (one female, one juv.) collected by Nuttall and Townsend are still in Philadelphia Academy of Natural Sciences. Honolulu (Lenz).

Parribacus papyraceus, sp. nov.

(Pl. XVIII, fig. 5.)

A small species closely related to *P. antarcticus.*

Carapace with sides convex, widest at tip of fourth tooth (counting from the front). Regions of carapace distinctly separated by smooth grooves. Tubercles raised, spaced, larger and more scanty in the middle and anterior portion. Median ridge armed with a tubercle on the rostral tooth, a second just in front of the posterior line of the orbits, a row of three on the gastric region, a row of six on the cardiac region. Dentation of margin of carapace and antennæ as in *P. antarcticus.*

Sternum of male with a median spine, between the intervals separating second and third and third and fourth pairs of feet; two spines side by side between feet of last pair; also a spine at base of each foot close to the articulation.

On coxa of last pair is a long curved spine directed down and back, beside the outward-projecting spine which is present in *P. antarcticus.*

The two specimens collected are not only of small size but of thin papyraceous texture, and may possibly be an immature stage of *P. antarcticus* or an allied species.

Dimensions.—Male, station 3821; length of body 58.2, length of carapace 21.4, width of carapace 32.3 mm.

Distribution.—South coast of Molokai Island, surface, station 3821 (type locality), one male (Cat. No. 30265). Hilo, Hawaii, H. W. Henshaw, one male.

Family PALINURIDÆ.

Panulirus japonicus (de Siebold).

(Pl. V.)

Palinurus japonicus de Siebold, Spicilegia Faunæ Japonicæ, 1824, p. 15. De Haan, Fauna Japon., Crust., p. 158, pls. XLI and XLII, 1841.

Palinurus longipes A. Milne Edwards, Nouv. Arch. Mus. Hist. Nat. Paris, IV, 1868, 87, pl. XXI (not *P.* (*Senex*) *longipes* Pfeffer, 1881).

Senex femoristriga Ortmann, Zool. Jahrb., Syst., VI, 1891, 23, and synonymy.

Senex japonicus Ortmann, op. cit., p. 25, and synonymy.

Honolulu, 1901, 1 female; 1902, 1 male (red variety). Honolulu market, Aug. 15, 1902; 1 male (figured), 1 juv., north coast of Maui, 69–78 fathoms, station 4073, 1 large male.

Laysan (Lenz); Hawaiian Islands (Pfeffer).

I think that *P. japonicus* and *P. longipes* (=*femoristriga*) can scarcely be regarded as distinct. We have in the Hawaiian series specimens in which the violet and yellow predominate, as in plate IV, and others that are red all over, except for yellow spots, spines, and abdominal stripes. Some have the anterior part of the carapace as hairy as in Japanese specimens. There remains only the character of the greater or lesser development of the spinules on the antennal segment as a distinguishing feature between the form as it exists in Japan and in the Indo-Pacific.

Panulirus penicillatus (Olivier).

Astacus penicillatus Olivier, Enc. Méth., Hist. Nat., Insectes, VI, 343, 1791.

Panulirus penicillatus Bate, Challenger Macrura, 82, pl. XII, fig. 2, 1888.

Senex penicillatus Ortmann, Zool. Jahrb., Syst., VI, 1891, 28.

Honolulu, 1891, 2 specimens; 1901, 1 specimen; 1902, 1 male. Kailua, 1901, 1 female. Hilo, Hawaii, 1901, 1 small female. Waiawa, Kauai, V. Knudsen, 1 specimen. Hawaiian Islands, Dr. W. H. Jones, U. S. N., 1 male, 1 female, in Museum of Comparative Zoology.

Panulirus marginatus (Quoy and Gaimard).

Palinurus marginatus Quoy and Gaimard, in Freycinet, Voyage autour du Monde, Zoologie, p. 537, 1824 (1825), atlas, pl. 81. Dict. Class. d'Hist. Nat., atlas, pl. [63]. Milne Edwards, Hist. Nat. Crust., II, p. 301 (footnote), 1837.

This species has not been observed since Quoy and Gaimard. It seems to be related to *Panulirus bürgeri* (de Haan), and *P. dasypus* (Latreille); according to the figure, there are four large spines and

no small spines on the antennal segment, and the abdominal furrows are uninterrupted. The original description is almost entirely of the color, and is here reproduced:

"*Palinurus birostratus; pedibus cyaneis albo maculatis; segmentis abdominalibus violaceis flavo marginatis.*

"Ce crustacé a le corselet brun, couvert de petites aspérités et d'aiguillons, dont deux plus considérables sont dirigés en devant; dans leur intervalle on en voit quatre plus petits. Les antennes, d'un rouge violacé à leur base, sont aussi, dans cette partie, armées de fortes épines; elles sont jaunâtres et couvertes d'aspérités dans le reste de leur longueur. Les antennules, bifurquées, très longues et verdâtres, ont des taches rougeâtres aux articulations.

"Les pattes sont bleu de ciel tacheté de blanc et velues à leur extrémité. Un beau violet bordé de jaune colore les anneaux de la queue; le crochet qui les termine de chaque côté est rougeâtre à la pointe. Les cinq plaques de la nageoire de la queue sont verdâtres, avec du jaune au milieu. Leur limbe est denticulé et bordé d'une bandelette noire avec un liséré blanc."

Family ERYONIDÆ.

Polycheles phosphorus (Alcock).

Pentacheles phosphorus Alcock, Ann. Mag. Nat. Hist. (6), XIII, 1894, 240; Illus. Zool. Investigator, Crust., Part II, pl. VIII, fig. 2, 1894.

Polycheles phosphorus Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., Calcutta, p. 168, 1901.

The large series of specimens exhibits additional variations to those given by Alcock. The lateral marginal spines of the carapace may be more numerous; there are frequently seven in front of the first sinus, sometimes five between the sinus and the cervical groove, and behind the groove there may be as many as ten; there may be five median spines between the anterior spine and the cervical groove.

The carpus and manus of the first pair of feet are usually finely spinulous above, while in one large specimen (station 3824) the merus is unarmed except for the terminal spine.

Color note attached to male, station 3816: Dorsum pale opaque rose madder, darkest on abdomen; ridges of carapace opaque white; swimmerets, thoracic legs and mouth parts deeper madder yet still pink.

Distribution.—Kaiwi channel, 298 to 470 fathoms, stations 3467, 3476, 4109, 4110, 4111, and 4112; south coast of Oahu Island, 228 to 337 fathoms, stations 3816, 3907, 3910, 3911, 3917, and 3920; south coast of Molokai Island, 222 to 498 fathoms, stations 3824, 3836, and 3839; Pailolo Channel, 277 to 684 fathoms, stations 3867, 3868, 3883, and 3884; north coast of Molokai Island, 328 to 809 fathoms, stations 3887 and 3892; vicinity of Modu Manu, 222 to 800 fathoms, stations 3979 and 4166; vicinity of Kauai Island, 55 to 703 fathoms, stations 3986, 3988, 3995, 3998, 4015, 4028, 4130, 4132, 4134, 4135, 4137, 4138, and 4187; between Honolulu and Kauai Island, 508 to 557 fathoms, station 4007; north coast of Maui Island, 253 to 283 fathoms, stations 4084 and 4085; northeast approach to Pailolo channel, 286 fathoms, station 4097; northwest coast of Oahu Island, 241 to 282 fathoms, stations 4116 and 4117.

Polycheles snyderi, sp. nov.

(Pl. XXIV, fig. 9.)

Carapace elongate-quadrate, depressed, lateral borders parallel except toward the extremities, its length equaling the abdomen less half the telson. Frontal border concave, armed with two spines at middle, one at each angle of orbit, and two or three between the outer orbital spine and the antero-lateral angle. Orbital notches deep, narrow-triangular; a spine at frontal end of eyestalk. Lateral borders armed with small spines, which are larger and fewer anteriorly; they number 10–6 to 8–30. Upper surface covered with rough granules from which hairs arise. Median carina double, spinulous, similar carinæ following both branches of the cervical groove. On either side of the branchial region a fine, oblique and sinuous line of spinules; an ill-defined line of larger spinules extending backward from the orbital sinus. The two longitudinal ridges of the side wall crenulate, the upper posteriorly obliterated.

The first to fifth abdominal terga and also the base of the seventh are bluntly carinated in the middle line, the carina not projecting nor spined.

Antennular scale a little larger than antennal scale, one-fifth as long as carapace, acute, upper margin spinose for its distal three-fifths, a single spine at outer distal angle. Antennal scale acute, tipped with a spinule, and reaching to end of antennular peduncle.

External maxilliped barely reaching end of antennular peduncle, and furnished with an epipod.

First thoracic leg a little longer than body; arm and palm with a distal spine above, wrist with a distal spine below. Upper and lower margin of arm and upper margin of palm spinulous. Propodus longer than merus, carpus longer than manus, digits one-third again as long as palm.

Second and fifth pairs of legs diminish in length and stoutness, the second pair more than one-third the length of the first pair; last pair imperfectly chelate in male.

Dimensions.—Male, length of carapace 35, entire length of abdomen 46.5, length of first pair of legs 85.2.

A single specimen only was taken at station 4151, vicinity of Modu Manu, 800 to 313 fathoms. (Cat. No. 30322.)

In shape the species resembles *P. phosphorus* (Alcock), but is at once distinguished by the uniform roughness of the carapace, the absence of true spines from the dorsal surface of carapace and abdomen and by the finer and more numerous spinules of the margin.

Named for Mr. J. O. Snyder, who accompanied the Fish Commission party in 1902.

FIG. 54.—*Polycheles granulatus*, station 4111, left antennal scale, × 2⅔.

Polycheles granulatus Faxon.

Polycheles granulatus Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, 197; Mem. Mus. Comp. Zool., XVIII, 1895, 123, pl. XXXII, fig. 1, pl. XXXIII, fig. 2, 2a.

Pentacheles Beaumontii Alcock, Ann. Mag. Nat. Hist. (6), XIII, 1894, 236; Illus. Zool. Investigator, Crust., pt. II, pl. VIII, fig. 3; Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., Calcutta, p. 175, 1901.

In Hawaiian specimens the number of lateral spines is 8 to 10-3 (or 4) -15 (14 or 16).

On the gastric region there are from 3 to 5 larger median spines behind the front, of which 1, 2, or more may be double.

Most of the specimens are small; the largest, a male, station 4111, measures 111.6 mm. long, length of carapace 50.8.

Color.—"Light opaque madder pink."

Distribution.—Vicinity of Kauai Island, 385 to 550 fathoms, stations 3989, 4019, 4028, and 4138; north coast of Molokai Island, 552 to 809 fathoms, station 3887; between Honolulu and Kauai Island, 508 to 557 fathoms, station 4007; Kaiwi channel, 460 to 470 fathoms, station 4111.

Polycheles asper, sp. nov.

(Pl. XXIV, fig. 11.)

Carapace nearly as long as exposed part of abdomen; strongly convex from side to side and also fore and aft; oval; surface covered with spinules and short hairs. Frontal margin concave, armed with two spines at the middle, one at inner angle of orbit; outer margin of orbital notch bordered with spines which are continued along the frontal margin halfway to lateral margin. Orbital notch narrow U-shaped; a large outward-pointing spine at extremity of eye. Lateral margins armed with spinules which diminish posteriorly and become almost obliterated. They number 15–8 or 10–28 or 29. Median carina double, armed with spinules larger than those of the general surface, and larger in front of than behind the cervical suture. Similar ridges of spinules follow the cervical suture along its posterior branch to the lateral margin and part way along the anterior branch; the longitudinal ridge of the branchial region is similar in position to that of *P. granulatus*. Longitudinal ridges of side wall finely granulate or denticulate, continuous.

Abdomen tuberculate; first to fifth terga bluntly carinate, as is also the anterior end of the sixth and seventh; the seventh carina only has a short backward-pointing spine.

Antennular scale subacute, not reaching beyond penult segment of peduncle, inner margin spined, a row of spinules at distal outer angle. Antennal scale suboval, reaching to distal third of last segment of peduncle.

The outer maxilliped reaches to middle of antennal scale, and is provided with an epipod.

First pair of thoracic legs missing; second pair two-thirds as long as carapace.

Dimensions.—Female, length of carapace 32.3, entire length of abdomen 38 mm.

Type locality.—Vicinity of Niihau Island, 735 to 865 fathoms, station 4174; 1 female (Cat. No. 30323).

This species has the form of *P. granulatus* Faxon, but the dorsal surface is much rougher, the carapace more convex, its side margins more finely and obscurely cut, abdominal carinæ, except the seventh, nonprojecting, antennal scale rounded at tip instead of pointed.

Eryoneicus indicus hawaiiensis, subsp. nov.

The differences between this specimen and *E. indicus* Alcock and Anderson [a] seem scarcely worthy of specific separation. On the posterior branch of the cervical ridge near its bifurcation there are two transversely placed spinules. On the left side the outer of these spinules is double. The longitudinal dorsal branchial ridge extends farther forward than in Alcock's figure, and is armed with numerous ill-defined spinules, except the posterior, which is a good sized spine. On the lower of the two ridges below the lateral carina there are about twelve spines of fair size. The second to fourth abdominal terga have each three median spines, of which the middle one is the largest; the fifth and seventh terga have two median spines.

Color.—Light or bleached poppy red shading to pale madder pink on inside of chelæ.

Vicinity of Kauai Island, 577 to 480 fathoms, station 4005; one female 41 mm. long. (Cat. No. 30324.)

Family HOMARIDÆ.

Enoplometopus occidentalis (Randall).

(Pl. XVII, fig. 2.)

Nephrops occidentalis Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 139. Gibbes, Proc. Amer. Assoc. Adv. Sci., III, 1850, 195. Stimpson, Jour. Boston Soc. Nat. Hist., VI, 1857, 495. Kingsley, Bull. Essex Inst., XIV, 1883, 131, pl. II, fig. 1.

Enoplometopus pictus A. Milne Edwards, Faune Carcinologique, in Maillard, Notes sur l'Ile de la Réunion, p. 14, pl. XIX, figs. 1, 1^a, 1^b, 1^c, 1862. Miers, Ann. Mag. Nat. Hist. (5), V, 1880, 380. De Man, Arch. f. Naturg., LIII, 1887, pt. 1, 488, pl. XXI, fig. 4. Ortmann, Jena. Denks., VIII, 1894, 21.

Enoplometopus occidentalis Ortmann, Zool. Jahrb., Syst., X, 1897, 274. (See Holmes, Occas. Papers Cal. Acad. Sci., VII, 1900, 167.)

Honolulu market, 1902, 1 male. Maui (Kingsley), in Museum Boston Society Natural History. Hawaiian Islands (erroneously labeled "N. W. coast of North America"), T. Nuttall, one male type, dried, in Museum of Philadelphia Academy.

Notes on the type specimen.—Length of carapace to orbit (rostrum broken off), 42.2 mm.; abdomen about 99.5 mm. Six median spines behind orbit; anterior one broken off and was probably the smallest; posterior one behind cervical suture. Four spines in next row, and outside the anterior of these and close to it, another spine. Posterior spine of the lateral row a little behind antepenult spine of the median row. No color marks remain. Telson a little longer than its basal width. Abdominal segments with a few low squamose tubercles, from which hairs have arisen. Antennal scale more elongate than represented in the figure by A. Milne Edwards, the postero-internal margin shorter. Left chela distinctly larger than right, 52.6 mm. long, 18 wide, dactyl 26 long: right chela 45.7 mm. long, 15.5 wide, dactyl 22.6 long. Arm and wrist substantially as shown by A. Milne Edwards; about eight or nine spines on upper surface of arm arranged in a double row; a single row of spines on each of the lower margins; in addition, two spines on distal margin of outer surface. Wrist irregularly spined around the distal margin; a few spines scattered on upper surface. Tubercles of palm larger through the middle of upper and lower surfaces, but all the tubercles smaller than in A. Milne Edwards's figure. Upper surface of palm covered with fine short pubescence except for a narrow strip through the center which is almost bare; lower surface less pubescent.

In size and general appearence our specimen agrees with A. Milne Edwards's figure; it measures 13.8 mm. in length. Of the five median spines, one is behind the cervical suture; the posterior of the

[a] *Eryonicus indicus* Alcock and Anderson, Ann. Mag. Nat. Hist. (7), III, 1899, 290. Alcock, Illus. Zool. Investigator, Crust., pt. IX, pl. I, fig. 3, 1901; Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., Calcutta, 1901, 176.

lateral dorsal row is opposite the antepenultimate of the middle row. The transverse row of large light-colored spots on the second to fifth abdominal segments contains six instead of five spots, there being two submedian, none median. Telson a little longer than its basal width. Right chela a little longer than left; its dactylus is a little shorter, that of the left chela a little longer, than its palm. Median rows of tubercles of palm small but distinct; other tubercles of upper and lower surface minute, set in a very short coat of pubescence.

Family STENOPIDÆ.

Stenopus hispidus (Olivier). *Bandana Prawn.*

Stenopus hispidus Brooks and Herrick, Mem. Nat. Acad. Sci., V, 1892, 326 and 339, pls. v–xiii.
Rathbun, Bull. U. S. Fish Comm., XX, 1900, (1901) 99, pl. ii, and synonymy.

Young specimens about 20 mm. long, are slenderer than the adult, with relatively longer rostrum, about three-fifths as long as remainder of carapace and devoid of lateral spines. Abdomen strongly bent at the third segment, which has a prominent median tubercle near posterior end; sixth abdominal segment very elongate, three or four times as long as fifth.

Distribution.—Honolulu; Honolulu Reef and market; Hilo, Hawaii, U. S. Fish Commission and H. W. Henshaw; Puako Bay, Hawaii, 1902; south coast of Oahu Island, station 3921, surface; between Honolulu and Kauai Island, station 3980, surface.

Spongicola henshawi, sp. nov.

(Pl. xxiv, fig. 8.)

Rostrum dorsally serrate with six spines besides one rudimentary, one spine below; over half as long as rest of carapace, reaching beyond antennular stalk. A spine below the orbit, and one on each side behind the base of the rostrum. Anterior margin below the orbit armed with spinules; a little farther back and parallel, a row of three or four larger spinules. Telson with two longitudinal rows of four spines each dorsally, edges spinulous, not reaching end of swimmerets, which are serrulate on outer margin. Eyes light olive in alcohol; a few spinules border the corneal margin and arm the anterior and dorsal surface of the stalk. Outer margin of acicle finely serrate. Outer maxillipeds stout, setose; second pair of legs equal in female, about twice as long as first pair and stouter; both pairs smooth; third pair sparingly setose, unequal (in female), much stouter than second pair, only the larger one longer than the second leg. Ischium with distal spine. Arm spinulous, a spine near distal end on upper and on outer side; wrist not much longer than broad, cup-shaped, distally spinulous above; hand broad, compressed, margins finely serrate, fingers bent down, narrow; a triangular tooth on the dactyl fits between one similar tooth and an obliquely truncate basal tooth on the thumb; fourth and fifth pairs very long, subequal; dactylus short, bifid; propodites posteriorly setose.

Length of egg-laden female 26.2 mm.

One specimen only from south coast of Molokai Island, 169 to 182 fathoms, station 3835. (Cat. No. 30538.) Named for Mr. H. W. Henshaw, formerly of Hilo, who has contributed much to our knowledge of the Hawaiian fauna.

Near *S. andamanica* Alcock,[a] but differs in longer rostrum, posterior position of spine at base of rostrum, longer, slenderer fingers, shorter telson.

Family PENÆIDÆ.

Penæus canaliculatus (Olivier).

Palæmon canaliculatus Olivier, Encyc. Méth., Hist. Nat., Insectes, VIII, 1811, 660.
Penæus canaliculatus Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 146 (part).
Penæus marginatus Randall, loc. cit. (part).
Penaeus canaliculatus Kishinouye, Jour. Fisheries Bureau, Tokyo, VIII, 1900, 11, pl. i, pl. vii, figs. 1, 1A, 1B, 1C, and synonymy.

Hawaiian Islands, Nuttall and Townsend, 5 specimens, in Museum of the Academy of Natural Sciences, Philadelphia. (See below under *P. marginatus.*)

[a] Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 148.

Penæus marginatus Randall.

(Pl. XIX, fig. 2.)

Penæus canaliculatus Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 146 (part).
Penæus marginatus Randall, loc. cit. (part).

Notes on the type specimens.—In the museum of the Philadelphia Academy of Natural Sciences are eight specimens labeled "*Peneus canaliculatus* Oliv., Sandwich Islands, Nuttall and Townsend." These were doubtfully named "*canaliculatus*" by Randall, therefore he suggested in print at the same time "*marginatus*" in case the species should prove to be new. The specimens are now in very bad condition, and have never been carefully examined. There are two species represented—five specimens of the true *P. canaliculatus* (Olivier), and three specimens which it seems proper to consider the types of *P. marginatus* Randall. All are half grown.

In the specimens of the well-known *P. canaliculatus*, the median ridge of the carapace is deeply grooved. The distance behind its posterior spine is from one and three-fourths to one and four-fifths times the distance in front of it measured to the posterior margin of the orbit. Only one individual now has a complete rostrum; its teeth are 9/1.

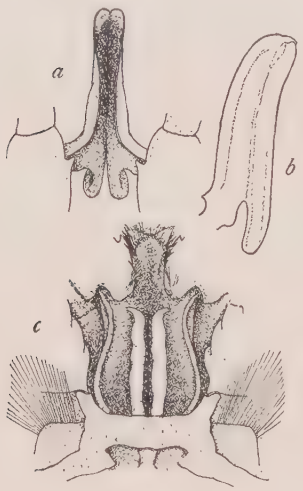

FIG. 55.—*Penæus marginatus*. *a*, Petasma, ventral view, station 3832, × 4. *b*, Same, side view, × 4⅘. *c*, Thelycum, station 4070, × 3⅘.

In the three examples of *P. marginatus* the median ridge is not grooved; the distance behind its posterior spine is one and two-thirds times the distance from the spine to the orbit. Two specimens have the rostrum intact, with 10/2 teeth.

Description of mature specimens in the U. S. National Museum: Size and general appearance same as that of *P. canaliculatus*. Dorsal crest 9–10 toothed, inferior rostral teeth 2–3. Dorsal keel continued nearly to posterior margin of carapace, itself not grooved, but bordered on either side by a broad furrow which extends posteriorly as far as the keel. Flagella of antennulæ as long or nearly as long as peduncle. Pereiopoda and abdomen much as in *P. canaliculatus*.

Petasma and thelycum similar to those of *P. ashiaka* Kishinouye and *P. monodon* Fabricius, the longitudinal median fissure of the latter bordered on either side by the much-thickened inner margin of the lateral plate.

Dimensions of largest specimen, a female, station 3857, 163 mm.

Description of young specimens.—Specimens 40 mm. in length and smaller, were taken in numerous hauls of the surface net. They are relatively slenderer than the more adult; the median carina and lateral grooves fade out before reaching as far back as in the adult, that is to say, about half way between the gastric spine and the posterior margin; the antennal scale is longer; the fourth abdominal segment is noncarinate, the sixth is noticeably longer than in the adult, the telson is armed close behind the small spines of the third pair with a pair of long spines. The color of this form is said to be French blue, and traces of it remain in the alcoholic specimens. It is possible that I am mistaken in attributing this young form to *P. marginatus*, but the general make-up, the rostral formula, and the probability of the existence of the young of that species in so large a collection, all tend to prove their identity.

Distribution.—The large and mature specimens are found only in deep water; medium and smallish specimens are restricted to shallow water along shore, while the very young occur at the surface.

Specimens 125 mm. and upward in length.—South coast of Molokai Island, 153 to 142 fathoms, station 3832; Pailolo Channel, 122 to 141 fathoms, stations 3857, 3858, 3897, 4102, and 4103. Vicinity of Laysan, 173 to 182 fathoms, station 3958; north coast of Maui, 45 to 52 fathoms, station 4070.

Specimens 40 to 95 mm. in length.—Honolulu, 1901; Pearl Harbor, April 23, 1902; Honolulu market, 1902; Hanalei, Kauai, June 23, 1902; Kaunakaki Harbor, Molokai, shallow water, station 3844; Hilo, Hawaii, 1901; Hilo, Hawaii, H. W. Henshaw.

Specimens 40 mm. and under in length.—Between Erben Bank and Kaiwi Channel, surface, station

3807; south coast of Oahu Island, surface, stations 3810, 3811, 3812, 3813, 3814, 3815, 3907, 3908, 3912, and 3921; south coast of Molokai Island, surface, stations 3821 and 3837; Pailolo Channel, surface, stations 3860, 3861, 3864, 3867, 3886, and 3901; south of Lanai Island, surface, 3880; north coast of Molokai Island, surface, station 3889; vicinity Laysan Island, surface, station 3932; between Honolulu and Laysan Island, surface, stations 3926 and 3930; vicinity of Kauai Island, surface, stations 3981 and 4018; between Kauai Island and Oahu Island, surface, station 4009; west coast of Hawaii Island, surface, station 4037; north coast of Maui Island, surface, station 4086; Honolulu, March 30, 1902, surface; Honolulu market, May 8, 1902; Hanalei, Kauai, June 21, 1902, surface.

Metapenæus affinis (Milne Edwards).

Penæus affinis Kingsley, Bull. Essex Inst., XIV, 1882, 105.

Parapenæus affinis Rathbun, Proc. U. S. Nat. Mus., XXVI, 1902, 38, and synonymy.

Hawaiian Islands (Kingsley).

Metapenæus velutinus (Dana).

(Pl. xx, fig. 5.)

Penæus velutinus Dana, Crust. U. S. Expl. Exped., I, 604, 1852; atlas, pl. xl, fig. 4, 1855. Bate, Challenger Macrura, 253 (part), pl. xxxiii, fig. 1 (probably not figs. 1″ and 1‴), 1888.

Distribution.—South coast of Molokai Island, 23 to 134 fathoms, stations 3845, 3846, 3847, 3848, 3849, 3850, 3853, and 3855; Pailolo Channel, 122 to 143 fathoms, stations 3857, 3858, 3859, 3897, 4101, and 4102; Auau Channel, 21 to 28 fathoms, station 3874; vicinity of Laysan Island, 16 fathoms, station 3962; vicinity of Kauai Island, 40 to 233 fathoms, stations 3982, 3987, and 4002; northeast coast of Hawaii Island, 63 to 107 fathoms, station 4064; Aleunihana Channel, 176 to 49 fathoms, station 4066; north coast of Maui Island, 52 to 152 fathoms, stations 4071, 4077, and 4098.

Dredged at Lahaina (Dana).

Our specimens are all of medium to small size (58 mm. and under).

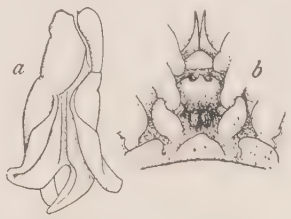

Fig. 56.—*Metapenæus velutinus*. *a*, Petasma, station 3897, × 4⅛. *b*, Thelycum, station 3859, × 3⅛.

Body pubescent. Rostrum reaching to middle of second antennular segment, with usually seven spines and, some distance behind, a gastric spine, behind which there is no carina; gastric spine at a point three-elevenths or a little more than one-fourth from the orbit to posterior margin of carapace. Rostrum slightly ascending, straight above and convex below as is usual in the female, or convex above and straight below as is usual in the male. Hepatic spine in line with gastric spine and almost in a longitudinal line with antennal spine.

Eyes very large, their greatest diameter just half as long as outer margin of acicle. This last three-fourths of length of carapace. Antennular flagella scarcely equaling last two joints of peduncle.

Outer maxillipeds reaching just to end of acicle. Second pair of feet exceeding antennal peduncle by length of fingers; third pair exceeding second by length of chela.

Basis and ischium of first pair each armed with distal spine; second pair unarmed. All the pereiopods are furnished with an exopod, while the last two pairs as well as the outer maxillipeds are destitute of an epipod.

Second to sixth abdominal somites carinate, carina increasing in strength posteriorly. Telson falling short considerably of the inner uropod; armed on either side with three movable spines, which increase rapidly in size posteriorly, and a fixed spine which is next to the terminal spine and is intermediate in size between the first and second pairs.

Petasma asymmetrical, the left branch longer and forming a hood which at the tip locks over the right branch; each branch with a small curved spine at extremity.

Length of carapace of female (station 4102) 21; of abdomen 37 mm.

Color, mottled with yellowish pink.

This species has not the abdominal hump or angle shown in Dana's figure, neither does the telson reach as near the end of the inner branch of the tail-fan as represented by Bate.

Metapenæus mogiensis (Rathbun).

(Pl. xx, fig. 3.)

Parapenæus mogiensis Rathbun, Proc. U. S. Nat. Mus., XXVI, 1902, 39, text figs. 6–8.

South coast of Molokai Island 6½ fathoms, station 3851, 1 male and 1 female of medium size.

Superficially has great resemblance to *M. velutinus*, but the carapace is relatively shorter; sixth abdominal segment shorter, eyes smaller, less than half as long as acicle.

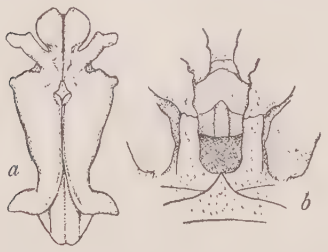

FIG. 57.—*Metapenæus richtersii*, station 3812. *a*, Petasma, × 10⅔. *b*, Thelycum, × 6⅔.

Metapenæus richtersii (Miers).

(Pl. xx, fig. 2.)

Penæus richtersii Miers, Zool. Alert, 564, pl. LII, fig. A, 1884.

South coast of Oahu Island, surface, electric light, station 3812, 1 male and 1 female; Pailolo Channel, surface, electric light, station 3860, 1 female.

The rostral teeth may be five or six, and in our specimens only one of them lies behind the orbit. The gastric tooth is about at anterior fourth of carapace. Rostrum higher, less acuminate than shown in Miers's figure. The posterior half of the fourth abdominal segment, as well as the fifth and sixth segments, is carinate; sixth segment terminating in a small spine.

Antennal flagellum as long as body exclusive of telson. Outer maxillipeds very much flattened and reaching only to end of antennal peduncle.

A spine on basis of first pair of legs but none on ischium; no spines on second or third pairs. Fifth pair of legs exceeding the fourth by the length of the dactylus.

The petasma is symmetrical, similar to that of *M. affinis* (Milne Edwards).[a] In a ventral view the terminal lobe on each side is followed on the outer margin by two lobes instead of one.

Our largest specimen, female, measured 42.8 mm. long, carapace 12.4.

Metapenæus evermanni, sp. nov.

(Pl. xx, fig. 1.)

A stout, pubescent species, with general appearance of *M. lamellatus* (de Haan), from which it differs in a less arched and lower rostrum, only one of whose eight teeth is situate behind the orbit; the gastric spine farther forward at the anterior two-fifths (rostrum exclusive) instead of at the middle of the carapace; a longer outer maxilliped, which exceeds the acicle by length of dactylus; the sternum of the female, while possessing a pair of spines between the bases of the feet of the second pair, and a single spine between those of the fourth pair, has also a spine between the feet of the fifth pair.

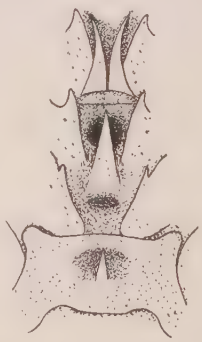

FIG. 58.—*Metapenæus evermanni*, station 3849, thelycum, × 4⅔.

All the legs are provided with exopods, only the first to third pairs with epipods.

Dimensions of female type.—Length of carapace and rostrum 18.5, of abdomen 40 mm.

Type locality.—One specimen only was obtained on the south coast of Molokai Island, 73 to 43 fathoms, station 3849 (Cat. No. 30539).

Solenocera lucasii Bate.

(Pl. xx, fig. 9.)

Solenocera Lucasii Bate, Ann. Mag. Nat. Hist. (5), VIII, 1881, 185.

Philonicus lucasii Bate, Challenger Macrura, 277, pl. XLII, fig. 4, 1888.

Pleoticus lucasii Bate, Challenger Macrura, p. lxii and 939, 1888.

Distribution.—South coast of Molokai Island, 73 to 43 fathoms, station 3849, 1 male; vicinity of Kauai Island, 55 to 50 fathoms, station 3987, 1 male.

[a] Kishinouye, Jour. Fisheries Bureau, Tokyo, VIII, 1900, pl. VII, fig. 5.

I think that this species should not be removed from *Solenocera*, the antennular flagella not differing essentially from those of *S. siphonoceros* (Philippi), a species which *S. lucasii* strongly resembles. In our largest specimen, 45 mm. long, the median carina is not continued behind the gastric region; dorsal spines 6–7, three of which stand behind the orbit (none behind the gastric region), no branchiostegal spine, though the carina leading to that point is strongly developed; eyes reaching beyond rostrum; the flagella of the antennula as long as the carapace less the rostrum, the larger one hollowed or longitudinally folded, and in the groove thus formed rests the more slender flagellum.

The carina of the third abdominal segment is less sharp than on the succeeding segments. The telson is sharp-pointed (Bate describes it as truncate, but in his single specimen the tip was probably broken off), falling short considerably of the end of the inner branch of the tail-fan.

The petasma is narrower than in *S. siphonoceros*, its distal half is trilobed on the ventral edge, the two most distal lobes ciliated.

Length of carapace, male (station 3849), 14 mm., of abdomen 31 mm.

The type specimen was 100 mm. long, which may account for the difference of some of its characters.

Haliporus equalis Bate.

Haliporus equalis Bate, Challenger Macrura, 285, pl. XLI, fig. 1, 1888.

Haliporus æqualis Wood-Mason, Ann. Mag. Nat. Hist. (6), VIII, 1891, 277; Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 23, 1901.

Distribution.—Kaiwi Channel, 335 to 460 fathoms, stations 3470, 3471, 3474, 3475, 4106, 4107, 4108, 4110, and 4112; vicinity of Kauai Island, 165 to 500 fathoms, stations 3988, 3989, 3997, 4022, 4028, and 4029; vicinity of Modu Manu, 293 to 1,059 fathoms, stations 4153, 4157, and 4166.

The median carina of the carapace is fairly distinct until near the posterior border; a low tubercle just in front of this border.

In some of the specimens the telson equals or somewhat exceeds the endopod of the tail-fan.

Haliporus modestus (Smith).

(Pl. xx, fig. 4.)

Hymenopenæus modestus Smith, Proc. U. S. Nat. Mus., VIII, 1885, 183.

Distribution.—South coast of Oahu Island, 183 to 280 fathoms, stations 3813 and 3920; vicinity of Laysan Island, 97 to 163 fathoms, stations 3938 and 3947; west coast of Hawaii Island, 198 to 147 fathoms, station 4045; north coast of Maui Island, 143 to 220 fathoms, stations 4079 and 4081; Pailolo Channel, 122 to 143 fathoms, stations 4101, 4102, and 4103; northwest coast of Oahu Island, 154 to 251 fathoms, stations 4114 and 4121.

I have not seen the type of *H. modestus* (Smith) from off Delaware Bay, 156 fathoms, but the description agrees in all essentials with the Hawaiian specimens.

The rostrum averages one-third the length of the carapace proper; of the seven dorsal spines, four may be on the carapace and three on the rostrum, or vice versa.

The upper of the antennular flagella equals in length the carapace (including rostrum) and the first two abdominal somites; the lower one equals the carapace and rostrum.

The antennal flagellum may attain three times the length of body.

The inner lamella of the tail-fan, though shorter than the telson, reaches preceptibly beyond it.

The leaves of the petasma are very broad, extremity oblique and three-lobed; a longitudinal plait divides the middle lobe.

Dimensions.—The largest specimen, a female (station 4101), measures 26.3 mm. on the carapace and 53.5 along the abdomen.

Aristeus semidentatus Bate.

(Pl. XIX, fig. 1.)

Aristeus semidentatus Bate, Ann. Mag. Nat. Hist. (5), VIII, 1881, 189; Illus. Zool. Investigator, Crust., pl. XLIX, fig. 3, male, 1901.

Hemipenæus semidentatus Bate, Challenger Macrura, 305, pl. XLIX, fig. 1, female, 1888.

Aristæus semidentatus Wood-Mason, Ann. Mag. Nat. Hist. (6), VIII, 1891, 280; Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 31, 1901.

Distribution.—Kaiwi Channel, 295 to 442 fathoms, stations 3470, 3472, 3474, 3475, 4105, 4106, and 4108; south coast of Oahu Island, 228 to 337 fathoms, stations 3815, 3910, 3911, 3916, and 3917; vicinity of Kauai Island, 165 to 500 fathoms, stations 3988, 3989, 4015, 4016, 4020, 4021, 4022, and 4025; west coast of Hawaii Island, 382 to 253 fathoms, station 4041; north coast of Maui Island, 267 to 283 fathoms, station 4085; northeast approach to Pailolo Channel, 308 to 306 fathoms, station 4088; north coast of Molokai, 328 to 809 fathoms, stations 3887 and 3892.

The rostrum of the female in Hawaiian specimens is usually shorter than the carapace, varying from about eight-ninths to just the length of the carapace. The acicle, on the other hand, runs somewhat longer than in the Indian form, its length being contained about one and a half times in the length of the carapace of the female, one and a fourth times or less in the male.

Color (from notes by the collector).—Rostrum, basal parts of antennæ, legs and sides of thorax, vermilion to orange vermilion. Legs punctate with burnt carmine. Dorsum of carapace, Payne's gray to purple, the viscera showing through. Eyes black, showing iridescent yellow. Abdomen light opaque pink except joints (articulations), which are yellowish salmon pink. Telson carmine or yellowish carmine.

Benthesicymus investigatoris Anderson.

Benthesicymus investigatoris Anderson, in Alcock and Anderson, Ann. Mag. Nat. Hist. (7), III, 1899, 282; Illus. Zool. Investigator, Crust., pl. XLI, fig. 2, 1899; Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 44, 1901.

Distribution.—South coast of Molokai Island, 222 to 498 fathoms, station 3824; north coast of Molokai Island, 552 to 809 fathoms, station 3887; vicinity of Modu Manu, 222 to 1,059 fathoms, stations 3977, 3979, 4153, and 4166; vicinity of Kauai Island, 339 to 703 fathoms, stations 3985, 3989, 3997, 4013, 4014, 4019, 4022, 4028, 4029, 4137, 4139, 4140, 4141, and 4187; Kaiwi Channel, 395 to 470 fathoms, stations 4109, 4110, 4111, 4112, 4113.

There are two teeth on the dorsal margin of the rostrum, besides the acuminate tip; behind the posterior tooth, there is a very small rudiment of a movable spine.

The carina of the fifth as well as of the sixth abdominal segment ends posteriorly in a small spine. Sixth segment twice as long as fifth.

Color.—Carmine.

Length of largest specimen, female (station 4110), 86 mm., carapace 32.2 mm.

FIG. 59.—*Benthesicymus laciniatus*, type, posterior half of telson, × 2⅔.

Benthesicymus laciniatus, sp. nov.

(Pl. XIX, fig. 3.)

Allied to *B. crenatus* Bate (Challenger Macrura, 329, pls. LIV and LV, 1888).

Two, instead of three, teeth on the dorsal surface of the rostrum. Median carina of carapace not evident behind gastric region. No hepatic spine.

Fourth segment of abdomen spinulous or laciniate on posterior margin; the spinules irregular, but increasing in size toward the middle; a short, transverse groove across middle of segment; behind it a median groove terminating in a prominent but short spine.

Telson armed with three spines on each side on the posterior half, besides the pair at the extremity.

First joint of antennula longer than eye-stalk; upper flagellum at least as long as carapace, including rostrum and first segment of abdomen; lower flagellum still longer. These flagella are incomplete in all the specimens.

Acicle less pointed than in *B. crenatus;* flagellum one and a half times as long as body.

Dimensions.—Female, length of carapace 48 mm., of abdomen 103 mm.

Distribution.—Vicinity of Kauai Island, 724 to 1,314 fathoms, stations 4018 (type locality), 4183, and 4185. Cat. No. of type, 30540.

Benthesicymus moratus Smith.

Benthesicymus? sp. indet., Smith, Rept. U. S. Fish Commr. for 1882, 397 [53], pl. x, figs. 3, 4, 5, 1884.

Benthesicymus? moratus Smith, Rept. U. S. Fish Commr. for 1885, 694 [90], 1886.

Vicinity of Kauai Island, 1,000 to 1,314 fathoms, station 4185, one male and one female, in poor condition. They agree very well with Smith's description (I have seen no Atlantic specimens) excepting that in the larger, a male about 95 mm. long, the third pleonic segment is not carinate, although in the small female (about 55 mm. long) it is obscurely so in the posterior half.

Benthonectes filipes Smith.

Benthonectes filipes Smith, Proc. U. S. Nat. Mus., VII, 1885, 509; Rept. U. S. Fish Commr. for 1885, 692 [88], pl. XVIII, figs. 1, 1*a*; pl. XIX, figs. 1, 1*a*, 1*b*, 1886.

Vicinity of Kauai Island, 508 to 703 fathoms, station 4187; one male.

In this specimen the rostrum has only one well-developed dorsal spine. In place of the posterior one in the figure there is a minute spinule which may represent an aborted spine.

Gennadas parvus Bate.

Gennadas parvus Bate, Ann. Mag. Nat. Hist. (5), VIII, 1881, 192; Challenger Macrura, 340, pl. LIX, 1888. Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 46, 1901.

Vicinity of Modu Manu, 636 to 850 fathoms, station 4154, one female.

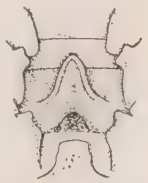

FIG. 60.—*Gennadas parvus*, station 4154, thelycum, × 6⅔.

This specimen has the characteristic thelycum described by Alcock.

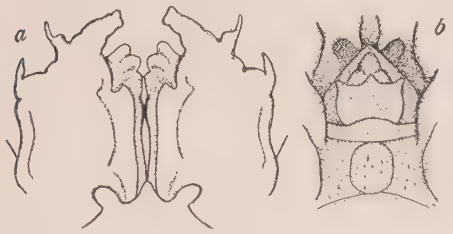

FIG. 61.—*Gennadas propinquus*, type. *a*, Petasma, × 12. *b*, Thelycum, × 2⅔.

Gennadas propinquus, sp. nov.

Between Erben Bank and Kaiwi Channel, two specimens, male and female, were taken in the intermediate tow-net at 100 fathoms, which are very close to *G. parvus* Bate, but the thelycum of the female is different from that described by Alcock (loc. cit.).

A small species (about 32 mm. long), with the rostral and the gastric spine very slender, the ophthalmic spine slender, the antennular peduncle with surface pubescent.

The thelycum shows a large subtriangular shield between the bases of the feet of the third pair, followed by a narrow transverse plate and then by a subcordate disk between feet of fifth pair.

The petasma in general form is similar to that of *G. parvus* Bate (op. cit., pl. LIX, fig. pp.), but is differently laciniated across the distal end.

A mutilated female from vicinity of Kauai Island, 478 to 453 fathoms, station 4029, is probably the same species. Cat. No. of type, 30541.

FIG. 62.—*Gennadas*, sp., station 4185, petasma, × 4.

Gennadas, sp.

One very soft and damaged male from vicinity of Kauai Island, 1,000 to 1,314 fathoms, station 4185, might pass for *G. borealis* Rathbun, but the petasma is larger than in that species, and the truncate lobe seen at the middle of its distal end (Harriman Alaska Exped., X, 1904, 148, fig. 89*a*) is replaced by a convex margin. The antennal scale appears to be narrower, but is incomplete.

Sicyonia lævis Bate.

(Pl. xx, fig. 7.)

Sicyonia lævis Bate, Challenger Macrura, 298, pl. xliii, fig. 5, 1888.

Distribution.—Pailolo Channel, 138 to 140 fathoms, station 3859; vicinity of Kauai Island, 233 to 40 fathoms, station 3982; three specimens in all.

Bate's single specimen was taken by the *Challenger* north of New Guinea in 150 fathoms. Our specimens agree fairly well with his description and figure. There is, however, no acute tooth below the orbit, but a very rounded one. The rostrum of only one is perfect, and that is a little different shape from Bate's figure—the tip is more broadly rounded and there are four teeth above and three terminal.

Sicyonia longicauda, sp. nov.

(Pl. xx, fig. 6.)

Surface covered with very short setæ, easily rubbed off.

Rostrum reaching beyond the eye-stalks, as far as the end of the first antennulary segment; strongly ascending; armed with three spines above, the posterior of which lies a little behind margin of orbit; tip oblique truncate, with three projections, a tooth between two spines. Dorsal carina prolonged nearly to posterior margin of carapace, armed with two strong teeth, one gastric and one cardiac, about as far distant from each other as the anterior one is from the spine at base of rostrum. A strong hepatic spine.

Abdomen sparingly sculptured; a strong sharp dorsal carina which forms an acute tooth on the first segment and ends in a similar tooth on the sixth segment; this segment unusually long, nearly twice as long as fifth. Telson longer than sixth segment, channeled above, a pair of lateral spines not far from the tip.

Eyes very large, horizontally flattened. Basal segment of antennule armed with two slender spines on its outer border. Flagella no longer than the second segment of the peduncle.

The peduncle of the antenna scarcely reaches the middle of the scale; flagellum, to last three segments of abdomen; basal segment armed with a strong outer spine.

Sternum armed with a flattened spine which arises between the bases of the legs of the fourth pair, but extends forward in advance of the bases of the third pair.

Both branches of swimming fan shorter than telson; outer branch shorter than inner.

Length 78; carapace 28 mm.

This species can be distinguished by its elongate sixth abdominal segment.

Distribution.—No species of *Sicyonia* has hitherto been found in a depth of more than 200 fathoms. Kaiwi Channel, 295 to 351 fathoms, stations 3467, 3472, 3475, 3476, and 4105; south coast of Oahu Island, 228 to 330 fathoms, stations 3815, 3907, 3908, 3909, 3914, 3916, 3917, 3918, and 3920; Pailolo Channel, 256 to 311 fathoms, station 3865 (type locality), 3866, 3867, 3883, 3884, 3898, 3899, 3900, and 3901; vicinity of Kauai Island, 53 to 324 fathoms, stations 4002, 4130, 4132, and 4134; north coast of Maui Island, 202 to 267 fathoms, stations 4081, 4082, 4083, and 4084; northeast approach to Pailolo Channel, 272 to 290 fathoms, stations 4095, 4096, and 4097; southwest coast of Oahu Island, 192 to 352 fathoms, station 4122. Cat. No. of type, 30823.

Family SERGESTIDÆ.

Sergestes tenuiremis Kröyer.

Sergestes tenuiremis Kröyer, Kongel. Danske Vidensk. Selsk. Skr., 5 Raekke, naturvidensk. math. afd., IV, 1859, 255 and 278, pl. iv, fig. 11*a–b*. Hansen, Proc. Zool. Soc. London, 1896, 949 and 951.

Between Erben Bank and Kaiwi Channel, station 3803, 50 fathoms, in open intermediate tow-net, one specimen.

Sergestes robustus Smith.

(Pl. XVIII, fig. 1.)

Sergestes, sp., Smith, Proc. U. S. Nat. Mus., III, 1881, 445.

Sergestes robustus Smith, Bull. Mus. Comp. Zool., 1882, X, 97, pl. XVI, figs. 5–8*b*; Rept. U. S. Fish Commr. for 1882, 416 [72], pl. VIII, figs. 3–6*b* (1884); Rept. U. S. Fish Commr. for 1885, 697 [93], pl. XX, fig. 6 (1886). Hansen, Proc. Zool. Soc. London, 1896, 949.

Sergestes bisulcatus Wood-Mason, Ann. Mag. Nat. Hist. (6), VII, 1891, 190; (6) VIII, 1891, 353. Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 210, pl. LII. Hansen, Proc. Zool. Soc. London, 1896, 949. Alcock, Illus. Zool. Investigator, Crust., pl. L, figs. 1–1*b*, 1901; Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 49, 1901.

Sergestes phorcus Faxon, Bull. Mus. Comp. Zool., XXIV, 1893, 217.

Distribution.—Kaiwi Channel, 313 to 460 fathoms, stations 3470, 3471, 3473, 4106, and 4110; vicinity of Kauai Island, 275 to 368 fathoms, stations 4025; west coast of Hawaii Island, 382 to 253 fathoms, station 4041.

Of the above specimens two only from stations 4106 and 4110 correspond to the typical form; the others differ only in having a small but distinct hepatic spine; the presence or absence therefore of this spine can not be considered a specific character.

There is no indication on the labels that the specimens did not come from the depths cited.

Sergestes edwardsii Kröyer.

Sergestes Edwardsii Kröyer, Kongel. Danske Vidensk. Selsk. Skr., 5 Raekke, naturvidensk. math. afd., IV, 1859, 246, 277, pl. IV, fig. 9*a–k*.

Sergestes edwardsii Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 212, pl. LI, figs. 1–1*e*. Perhaps not *S. halia* Faxon. (See Hansen, p. 962.)

Sergestes edwardsi Hansen, Proc. Zool. Soc. London, 1896, 950 and 961.

Two small specimens were taken in 50 fathoms in the open intermediate tow-net at station 3806, between Erben Bank and Kaiwi Channel.

Sergestes oculatus Kröyer.

Sergestes oculatus Kröyer, Kongel. Danske Vidensk. Selsk. Skr., 5 Raekke, naturvidensk. math. afd., IV, 1859, 243 and 277, pl. III, fig. 5*a–f*. Bate, Challenger Macrura, 406, pl. LXXIV, fig. 1, 1888. Hansen, Proc. Zool. Soc. London, 1896, 950 and 963.

Distribution.—Between Honolulu and Laysan, surface, station 3929; vicinity of Kauai Island, surface, station 3981; west coast of Hawaii Island, surface, station 4037; 4 specimens in all.

Specimens about 12 and 13 mm. long.

Recorded by Bate from 5° south of Hawaiian Islands, and near the Hawaiian Islands.

According to Hansen this is the *Mastigopus* of *S. edwardsii*.

Sergestes parvidens Bate.

Sergestes parvidens Bate, Challenger Macrura, 409, pl. LXXIV, fig. 3, 1888. Hansen, Proc. Zool. Soc. London, 1896, 950 and 964.

North of Hawaiian Islands (Bate).

According to Ortmann and Hansen a young stage of *S. vigilax* Stimpson.

Sergestes armatus Kröyer.

Sergestes armatus Kröyer, Kongel. Danske Vidensk. Selsk. Skr., 5 Række, naturvidensk. math. afd., IV, 1859, 260 and 279, pl. III, figs. 6*a–e*. Bate, Challenger Macrura, 401, pl. LXXIII, fig. 1, 1888. Hansen, Proc. Zool. Soc. London, 1896, 950 and 966.

Between Erben Bank and Kaiwi Channel three specimens, taken in surface tow-net. The largest, about 17 mm. long, bears a spine on each of the first five abdominal segments, while the other two specimens, each about 10 mm. long, have spines on the second to fifth segments.

Recorded by Bate, north of Hawaiian Islands, latitude 30° 22′ north, longitude 154° 56′ west, and also between Honolulu and Japan.

Sergestes ventridentatus Bate.

Sergestes ventridentatus Bate, Challenger Macrura, 431, 1888. Hansen, Proc. Zool. Soc. London, 1896, 951.

North of Hawaiian Islands (Bate).

Leucifer acestra (Dana).

Lucifer acestra Dana, Crust. U. S. Expl. Exped., I, 671, 1852; atlas, pl. XLIV, fig. 9*a–i*, 1855. Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 214 and synonymy.

Distribution.—Between Erben Bank and Kaiwi Channel, 50 fathoms, station 3803; between Honolulu and Laysan Island, surface, station 3926; vicinity of Kauai Island, surface, station 3981; Hawaii (Bate).

Family CRAGONIDÆ.

Pontophilus gracilis Smith.

Pontophilus gracilis Smith, Bull. Mus. Comp. Zool., X, 1882, 36, pl. VII, figs. 2–3*a*; Rept. U. S. Fish Commr. for 1885, 654 [50], pl. XI, figs. 1–2, 1886. Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 115, 1901, and synonymy.

Distribution.—South coast of Molokai Island, 430 to 371 fathoms, station 3826; between Honolulu and Kauai Island, 508 to 557 fathoms, station 4007; vicinity of Kauai Island, 286 to 804 fathoms, stations 4018, 4021, and 4137; west coast of Hawaii Island, 670 to 697 fathoms, stations 4036 and 4039; vicinity of Modu Manu, 762 to 1,059 fathoms, stations 4153 and 4157.

The specimens do not exceed 30 mm. in length.

Pontophilus modumanuensis, sp. nov.

A small species, represented by only one specimen from vicinity of Modu Manu, 293 to 800 fathoms, station 4166 (Cat. No. 30543).

Carapace with rostrum as long as first three and a half segments of abdomen.

FIG. 63.—*Pontophilus modumanuensis*, type, carapace and antennal region, × 4⅔.

Rostrum long, slender, spiniform, exceeding eyes a little but not nearly reaching end of first antennular segment; armed on basal half with two spines on each side.

Two median spines just behind the rostrum, the anterior the smaller. Median carina stopping short of posterior margin of carapace. Two lateral carinæ; the upper unarmed and continuous with the side margins of the rostrum; lower carina very short, terminating anteriorly in a spine which is slightly behind the posterior median spine. A small antennal, a long branchiostegal spine.

Abdomen almost smooth, punctate, telson wanting.

Eyes light reddish-brown in alcohol.

Basal spine of antennula very slender and reaching nearly to end of first antennular segment; peduncle not reaching middle of acicle; third segment half as long as second; flagella half as long as carapace (rostrum inclusive); outer flagellum a little thicker and shorter than inner. Scale of antenna also about half as long as carapace, its spine exceeding blade. A small spine on outer side of second antennal segment; peduncle reaching to middle of second antennular segment; flagellum nearly as long as body.

The maxillipeds overreach the acicle by one-fourth length of their last segment.

The first pair of legs reach just to end of acicle; the second pair halfway along merus of first pair; third pair exceed acicle with last two joints; fourth pair reach just to end of acicle; fifth pair about same length, tip broken.

Length of carapace and rostrum 5.3 mm., length of abdomen, telson excluded, 10.5 mm.

Egeon orientalis Henderson.

(Pl. XXIII, fig. 3.)

Ægeon orientalis Henderson, Trans. Linn. Soc. London (2), Zool., V, 1893, 446, pl. XL, figs. 16, 17.

Distribution.—Vicinity of Kauai Island, 286 to 399 fathoms, station 4021, 2 females; vicinity of Modu Manu, 293 to 800 fathoms, station 4166, 1 female.

The rostrum is distinctly bispinose, with a smaller spine either side at base. Median carina with five spines, of which the middle one is somewhat smaller. First or upper lateral carina 7-spined, second row 8 to 10-spined, lower row 6-spined, including the antero-lateral spine. The spines of the two lower rows diminish in size posteriorly, and the spines of the lowest row end halfway back on the carapace.

The first, fifth, and sixth abdominal somites have each a pair of submedian carinæ; the second, third, and fourth somites have each one median carina; the first, second, third, and fifth somites have two lateral carinæ on each side; the fourth somite three lateral carinæ on each side; the sixth somite one carina on each side. The six carinæ of the first somite and the median carina of the second somite end anteriorly in a spine; the median carina of the fourth somite and the submedian pair of the fifth and sixth somites terminate posteriorly in a spine, while the submedian keels of the sixth somite have also a spine at their posterior third.

Henderson describes the second, third, and fourth segments with only a single lateral keel; but his figure contradicts this. No rostral spines or teeth are shown in the figure.

Egeon habereri (Doflein).

Pontocaris habereri Doflein, Abh. math.-phys. Cl. k. bayer. Akad. Wiss., München, XXI, 1902, 620, pl. I, figs. 4 and 5, text fig. A.

Distribution.—Pailolo Channel, 127 to 138 fathoms, stations 3857 (1 male) and 3858 (1 female).

Female larger than male; carapace 11.8 mm. long, abdomen about 32 mm.

The median carina of the male is four-toothed, of the female five-toothed. Besides the two main rostral teeth, there is a very small one on either side at the base.

Of the antennular flagella in the female, the outer is not more than half as thick as the inner.

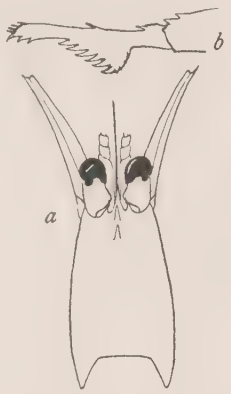

FIG. 64.—*Rhynchocinetes rugulosus*. *a*, Carapace and antennal region, × 5⅜. *b*, Rostrum, × 4⅛.

Family RHYNCHOCINETIDÆ.

Rhynchocinetes rugulosus Stimpson.

Rhynchocinetes rugulosus Stimpson, Proc. Phila. Acad. Nat. Sci., XII, 1860, 36 [105].

? Rhynchocinetes typus Borradaile, in Willey, Zool. Results New Britain, etc., pt. IV, 415, 1900.

French Frigate Shoal, 17 to 17½ fathoms, station 3970, one small specimen about 16 mm. long.

Rostral formula $\frac{4-4}{11}$. Stimpson's type from Port Jackson, Australia, was 2 inches long, and had three instead of four teeth near tip of rostrum above and twelve teeth below. The last two segments of the abdomen of the Hawaiian specimens are noticeably longer than in the Chilean specimens of *R. typus* collected by the U. S. Exploring Expedition. Owing to the very great difference in the size, it is impossible to compare the rugæ of the carapace. It may appear that the Hawaiian form represents an undescribed species.

Family LYSMATIDÆ.

Processa processa (Bate).

(Pl. XXII, fig. 6.)

Nika processa Bate, Challenger Macrura, 527, pl. XCV, 1888.

Distribution.—Honolulu Reef, May 8, 1902; Auau Channel, 21 to 43 fathoms, stations 3872 and 3874. Six specimens in all.

The rostrum is compressed, carinate, as long as eye, extremity oblique, bispinose, a shorter spine above, longer one below, a few hairs between.

The eyes are very large, flattened, and have a small but distinct and dark-colored ocellus on the border of the cornea and mainly outlined against the peduncle. The antennular peduncle is as long as the acicle; the antennal peduncle reaches just to end of basal joint of antennular peduncle.

The outer maxilliped and the simple foot of the first pair exceed the acicle by length of their last segment, while the cheliped of the first pair is barely as long as the acicle.

Feet of second pair unequal; right foot exceeding acicle by half its merus besides carpus and chela, merus feebly subdivided, carpus with about 65 segments; left foot exceeding acicle by length of chela and nearly all the carpus, merus also feebly segmented, carpus with thirty subdivisions.

A specimen from station 3876 presents a curious variation; the small upper spine of the rostrum is found much farther back, at the middle of the rostrum, which from that point tapers anteriorly in a long acuminate spine.

Processa hawaiensis (Dana).

Nika hawaiensis Dana, Crust. U. S. Expl. Exped., I, 538, 1852; atlas, pl. XXXIII, fig. 7*a–h*, 1855.

Lahaina, Maui (Dana).

According to Dana the rostrum is shorter than the eyes and broader than long; the antennular peduncle longer than acicle; antennal peduncle nearly as long as acicle. Carpus of feet of second pair with eleven joints.

Family HIPPOLYTIDÆ.

Hippolyte acuta (Stimpson).

(Pl. XXIV, fig. 3.)

Virbius acutus Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 104 [35].

Reef in front of Honolulu, August 16, 1901, one ovigerous female; one additional ovigerous female without label was taken in 1901.

These agree very well with Stimpson's description, except that the telson is armed dorsally with only two pairs of aculei.

Hippolysmata acicula, sp. nov.

(Pl. XXIV, fig. 6.)

Differs from *H. rittata* Stimpson, of which I have seen no examples, in the longer antennal scale, which exceeds considerably the antennular peduncle and is nearly as long as the carapace, rostrum excluded; in the outer maxilliped exceeding the acicle by only the half of its terminal joint; in the greater number of segments (29) of the carpus of the second pair of feet.

The rostral formula is $\frac{5-6}{2-5}$, the rostrum reaching to the distal third, as in the largest specimen, or to the end, as in smaller specimens, of the penult segment of the antennular stalk; two teeth are on the carapace, the posterior in front of middle. The antennal flagellum is sometimes nearly twice as long as body; in the largest specimen it is broken off.

Dimensions.—Female type, length 27.8, length of carapace with rostrum 9.8, without rostrum 6.8, length of acicle measured on outer margin 5.8 mm.

Distribution.—Vicinity of Kauai Island, 7 to 148 fathoms, station 3999, 1 female type (Cat. No. 30544); Honolulu, from bottom of tugboat, July 3, 1902, 4 specimens.

Hippolysmata paucidens, sp. nov.

(Pl. XXIV, fig. 4.)

A smaller species than the last.

Rostral formula $\frac{4}{1-2}$; teeth smaller, two behind the orbit, the posterior one at the anterior third of the carapace or farther forward than in preceding species. Rostrum barely reaching end of first antennular segment. Acicle shorter than in *H. acicula*, not two-thirds length of carapace, rostrum excluded. Outer maxilliped exceeds acicle by three-fourths of its terminal joint. Twenty-three segments in carpus of second pair of feet. From *H. vittata* our species is distinguished by its shorter rostrum and fewer teeth.

Dimensions.—Female type, length 18, length of carapace with rostrum 6.2, without rostrum 4.5, acicle (outer margin) 2.6 mm.

Distribution.—Honolulu, 1901; Waikiki beach, August 14, 1901 (type locality); Laysan, May, 1902; 10 specimens in all. Cat. No. of type, 25411.

Spirontocaris marmorata (Olivier).

Palæmon marmoratus Olivier, Encycl. Méth., Hist. Nat., Insectes, VIII, 665, 1811; atlas, XXIV, pl. 319, fig. 3, 1818.
Alpheus marmoratus Lamarck, Hist. Anim. sans Vert., V, 205, 1818.
Hippolyte marmoratus Milne Edwards, Hist. Nat. Crust., II, 379, pl. XXV, figs. 8 and 9, 1837.
Hippolyte gibberosus Milne Edwards, Hist. Nat. Crust., II, 378, 1837.
Hippolyte gibbosus Streets, Bull. U. S. Nat. Mus., No. 7, 1877, 119, and synonymy.
Hippolyte gibberosa de Man, Arch. f. Natur., LIII, 1887, pt. 1, 533.
Hippolyte marmorata de Man, loc. cit.

Honolulu, 1901; Honolulu Reef, May 8, 1902; Oahu, Dr. T. H. Streets, U. S. Navy; Oahu, Sharp. Hawaiian Islands (Randall, Gibbes); 3 fragmentary specimens, T. Nuttall, collector, in Philadelphia Academy of Natural Sciences. Hawaiian Islands (Dana).

The difference between the species *marmorata* and *gibberosa* seems to consist solely in the length of the outer maxilliped, which I am inclined to think is dependent on maturity. In the limited series before me, specimens about 57 mm. long have the terminal joint of the maxilliped greatly elongate, exceeding the acicle by half its length. In a specimen 41.5 mm. long (Oahu), the maxillipeds reach just to end of acicle; in specimens about 22 mm. long, a little past middle of acicle.

Specimens of a very young hippolytid were taken at the surface on the south coast of Oahu at stations 3812 and 3921. They average about 7 mm. in length and are probably the young of *S. marmorata*.

Spirontocaris kauaiensis, sp. nov.

(Pl. XXIV, fig. 5.)

Dorsal carina occupying three-fourths of the carapace, armed with three large spines, of which one is behind the orbit and two above the eyes. The anterior one may stand in front of eyes. Rostrum one and two-thirds times as long as carapace, curved strongly upward, armed with 8 spines below; one subterminal above. A strong antennal spine. Pleon smooth; sixth more than twice as long as fifth segment and a little longer than telson, which has two pairs of lateral spinules. Eyes large. Second and third antennular segments very short, subequal; basal scale not exceeding first segment; peduncle reaching to middle of acicle; longer flagellum at least as long as pleon. Acicle just as long as carapace; antennal peduncle reaching to end of second antennular segment. The outer maxillipeds reach past middle of acicle; first pair of trunk legs, to end of antennal peduncle; second pair end halfway between tip of maxilliped and tip of scale. The outer maxilliped is provided with an exopod and epipod; the first and second trunk legs only with an epipod, all destitute of exopods.

Dimensions.—Female, length of carapace 8.7, rostrum 17, abdomen (telson excluded) 26 mm.

Distribution.—Vicinity of Kauai Island, 55 to 362 fathoms, stations 3986 and 3998 (type locality); northwest coast of Oahu Island, 216 to 251 fathoms, station 4121; 4 specimens in all. Cat. No. of type, 30545.

This species, by having three teeth at the base of the rostrum and in the elongate sixth segment of pleon, resembles *S. tridens* Rathbun, but that species has the rostrum shorter and more horizontal and the third abdominal segment subcarinate.

Spirontocaris profunda, sp. nov.

(Pl. XXIV, fig. 10.)

Carapace stout, carinated in its anterior two-thirds. Rostrum slender, about one-third as long as carapace, not reaching end of first antennular segment, horizontal; dorsal spines two, the posterior one in line with the supraorbital spine and just in advance of the line of the orbit; one spine below, near the tip, which is acuminate. Anterior margin armed with three spines, one supraorbital, one antennal, one much smaller at the antero-lateral angle.

Antennular peduncle two-thirds as long as carapace, first segment twice as long as second, which is three times as long as third; basal scale reaching nearly to end of first segment, which last has on its distal margin a spine at the outer angle and two very slender ones above; antero-external angle of second segment armed with a slender spine, of third segment with two spines. Flagella about as long as peduncle.

The antennal scale exceeds the antennular peduncle, its blade is oblique and overreaches the spine; the peduncle reaches to the end of the second antennular segment. Flagellum as long as the body less the telson.

Outer maxillipeds stout and very long, extending beyond acicle by length of last joint and nearly half of the penult. They are without exopod, but have an epipod as have also the first three pairs of trunk legs. The stout first pair extend to middle of terminal joint of maxilliped; the second pair are a little longer than the first; carpus of nine segments.

Fifth and sixth abdominal somites armed with a postero-lateral spine; fifth one and a half times as long as sixth segment; telson as long as fifth and sixth together, with four spinules on one side and five on the other.

Dimensions.—Female, length 46, of carapace and rostrum 15, of rostrum 4.3 mm.

Type locality.—Vicinity of Modu Manu, 762 to 1,000 fathoms, station 4157; 1 female (Cat. No. 30546).

This species is near *S. washingtoniana* Rathbun, found in deep water off the State of Washington, but has a much shorter rostrum and longer maxillipeds.

Family PANDALIDÆ.

Pandalus martius A. Milne Edwards.

Pandalus martius A. Milne Edwards, Recueil Planches Expéd. "Travailleur," pl. XXI, 1883.
Plesionika Martia Caullery, Ann. Univ. Lyon., 1896, "Caudan" Crust., p. 378, pl. XV, figs. 1–6.
Pandalus (*Plesionika*) *martius* Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 95, 1901 and synonymy.

This is the common sword shrimp of deep water about the islands, over 700 specimens having been taken by the *Albatross* in fifty hauls.

Color.—Carapace translucent, showing anatomy. Whole body covered with fine vermilion dots, including rostrum, eyestalks, antennal scale and swimmerets. Joints of abdomen brighter red. Legs and antennæ bright Chinese vermilion. Eyes gray, showing yellow by reflected light. Eggs opaque cobalt blue.

Distribution.—Kaiwi Channel, 295 to 351 fathoms, stations 3467, 3471, 3472, 3473, 3474, 3475, 3476, 4105, and 4106; south coast of Oahu, 228 to 337 fathoms, stations 3815, 3817, 3818, 3907, 3908, 3909, 3910, 3911, 3912, 3914, 3916, 3917, 3918, and 3925; Pailolo Channel, 256 to 684 fathoms, stations 3865, 3866, 3867, 3868, 3883, 3884, 3898, 3899, 3900, and 3901; vicinity of Kauai, 165 to 469 fathoms, stations 3988, 4015, 4016, 4021, 4025, 4130, 4134, 4135, and 4136; west coast of Hawaii, 382 to 253 fathoms, station 4041; north coast of Maui, 253 to 283 fathoms, stations 4084 and 4085; northeast approach to Pailolo Channel, 286 to 308 fathoms, stations 4089, 4091, and 4095; northwest coast of Oahu, 282 to 253 fathoms, station 4117; vicinity of Niihau Island, 319 to 378 fathoms, station 4178.

Pandalus ensis (A. Milne Edwards).

Acanthephyra ensis A. Milne Edwards, Ann. Sci. Nat., Zool. (6), XI, 1881, art. 4, p. 14.
Pandalus ensis A. Milne Edwards, Recueil Planches Expéd. "Travailleur," pl. XVIII, 1883.
Pandalus (*Plesionika*) *ensis* Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 96, 1901.

This species can be most readily distinguished from the preceding, *P. martius*, by the median spine on the posterior border of the third abdominal segment and the greater length of the sixth segment, which is longer than the telson. The last three pairs of legs are also appreciably shorter.

Less abundant than *P. martius*, only 128 specimens having been taken in twenty-eight hauls.

Color.—Ground tint pearly or milky semiopaqueness, the viscera clearly showing through the thorax. End of rostrum, tips of legs and abdomen at edges of joints vermilion. Spots of same color along sides of abdomen; terminal half of abdomen finely dotted, and telson marked with vermilion.

Distribution.—Kaiwi Channel, 220 to 346 fathoms, stations 3467, 3472, 3473, and 3893; south coast of Oahu, 228 to 369 fathoms, stations 3815, 3914, 3920, and 3922; Pailolo Channel, 256 to 684 fathoms, stations 3865, 3868, 3883, 3884, and 3901; vicinity of Laysan, 351 to 347 fathoms, station 3952; vicinity of Kauai, 55 to 469 fathoms, stations 3986, 3988, 3990, 3998, 4130, 4131, 4132, 4134, and 4135; north coast of Maui, 253 to 283 fathoms, stations 4084 and 4085; northeast approach to Pailolo Channel, 290 to 286 fathoms, station 4095; northeast coast of Oahu, 282 to 253 fathoms, station 4117; vicinity of Niihau Island 319 to 378 fathoms, station 4178.

? Pandalus ocellus (Bate).

(Pl. xxi, fig. 1.)

Nothocaris ocellus Bate, Challenger Macrura, 657, pl. cxiv, fig. 3, 1888. Not *?Pandalus* (*Plesionika*) *ocellus* Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 97, 1901.

I am in doubt as to the identity of this form with Bate's; it seems much nearer to his figure and description than does the Andaman specimen placed here hesitatingly by Alcock.

The only discrepancy of any consequence is this, that the feet of the second pair are equal and similar, while, according to Bate, the left carpus is nearly twice as long as the right. Whether this has been correctly reported or not remains to be seen.

In the Hawaiian specimens the two posterior dorsal spines are small, close together, and movable; then follow about six larger and more separated fixed spines, and then from four to six very small fixed and still more distant spines which reach to the tip; below are seven or eight small fixed spines which begin a little in front of the antennular peduncle, which is farther back than Bate describes them. It must be remembered that he had only two specimens, and only one with rostrum.

The second pair of feet overreach the maxillipeds by the length of the chela and seven or eight joints of the carpus. The third, fourth, and fifth pairs of feet diminish in length in the order named; the third exceeds the maxilliped by the dactylus, propodus, and three-fourths of the carpus; the fifth reaches to end of proximal third of propodus of third.

Distribution.—South coast of Molokai Island, 115 to 134 fathoms, station 3853; Pailolo Channel, 122 to 143 fathoms, stations 3856, 3858, 4101, 4102, 4103, and 4104; Auau Channel, 126 to 130 fathoms, station 3896; vicinity of Kauai Island, 230 to 53 fathoms, station 4002; north coast of Maui Island, 45 to 52 fathoms, station 4070.

Pandalus sindoi, sp. nov.

(Pl. xxi, fig. 4.)

Near the preceding, *P. ocellus.* Differs in having the posterior four (instead of two) dorsal spines small, subequal and close together, although only the posterior two or three are movable. Eyes considerably larger. Antennular peduncle not reaching to end of second segment of antennular peduncle. Second pair of feet overreaching tip of maxilliped very slightly, not more than length of chela. Sixth abdominal segment longer, twice as long as fifth segment; telson correspondingly elongate.

Named for M. Sindo, of the Fish Commission party of 1901.

Only three adult specimens were taken, all fragmentary; two male (type, Cat. No. 30547) from station 3998, vicinity of Kauai Island, 235 to 228 fathoms, and one female, station 3953, vicinity of Laysan Island, 347 to 264 fathoms; also one young from station 3846, south coast of Molokai Island, 64 to 60 fathoms.

Dimensions.—Length of male 58, length of carapace 10.4, rostrum 16.2, abdomen 32.4, sixth abdominal segment 7.6, telson without terminal movable spines 7.5 mm. Length of larger male, exclusive of rostrum which is broken, 52.5 mm.

This may be *Pandalus* (*Plesionika*) *ocellus* Alcock non Bate (Desc. Cat., p. 98) of which there was only a single specimen, lacking the right leg of the second pair.

Pandalus brevis, sp. nov.

(Pl. XXI, fig. 3.)

Nearest to the European *P. brevirostris* Rathke. Although the dorsal carina arises behind middle of carapace, the spines begin at the anterior fifth. Rostrum short, as in the allied species, reaching to middle of second segment of antennula, armed with eleven to twelve spines above (five behind the orbit and none near the tip) and one below.

Surface microscopically pitted, the punctæ forming short transverse rows on the carapace.

FIG. 65.—*Pandalus brevis*, type, rostrum, × 5⅜.

Eyes very short and stout, cornea covering nearly whole of stalks; ocellus marginal, projecting a little from the cornea.

Last two antennular segments of equal length; peduncle two-thirds as long as antennal scale; the latter a little more than half as long as carapace (rostrum excluded); antennal peduncle extending to middle of last segment of antennular peduncle.

Outer maxilliped with exopod. First thoracic foot reaching nearly to end of acicle. Feet of second pair equal, stretching to a little beyond acicle, carpus 11-segmented. Fourth foot exceeding acicle by last segment and over half of penult segment. Epipods absent from last pair of legs only.

Sixth segment of pleon nearly twice as long as fifth; telson broken off.

Dimensions.—Length of carapace proper 7.8, rostrum 2.7, abdomen, exclusive of telson, 16 mm. The specimen from station 4139 is very much mutilated but considerably larger, about 50 mm. long.

Distribution.—Vicinity of Kauai Island, 512 to 339 fathoms, station 4139, 1 female; vicinity of Niihau Island, 426 to 417 fathoms, station 4180, 1 male (type, Cat. No. 30548).

Pandalus exiguus, sp. nov.

(Pl. XXI, fig. 2.)

A small species; body bent at a right angle at the third abdominal segment.

Rostrum about one and three-fourths as long as the carapace, bent strongly downward in front of eyes, terminal half ascending; spines of dorsal crest beginning at distal third of carapace, six or seven in number, the posterior one minute, then increasing anteriorly for four or five spines and becoming more horizontal; rostrum in front of eyes unarmed except near the tip, where there are two small spines, lower margin armed with eight to ten spines.

FIG. 66.—*Pandalus exiguus*. station 4062, left eye, × 4⅛.

Abdomen nearly four times as long as carapace, slightly compressed but scarcely cristate at third segment, which is moderately produced at middle of posterior margin. Sixth segment twice as long as fifth and just as long as telson, which is armed with three pairs of side spines; inner uropods intermediate in length between telson and outer uropods. Eyes large, but transverse diameter not exceeding axial. Ocellus very large, extra-corneal. Antennular peduncle reaching to middle of acicle; second and third joints subequal. Acicle nearly as long as carapace, rounded at end which is in line with tip of spine. Antennal peduncle nearly reaching end of second segment of antennular peduncle. Maxillipeds reaching just beyond the tip of acicle; first pair of perciopods same length. The left leg of the second pair exceeds the rostrum, its carpus composed of about 40 segments; the right leg does not reach end of acicle, its carpus with 12 segments. The last three legs vary little in length; the last pair exceeds acicle by length of dactylus and a small bit of the propodus; the spines of the merus are of good size.

Dimensions.—Length of carapace of type, ovigerous female, 4.3, length of rostrum 7.5, length of abdomen 17 mm.

Distribution.—Vicinity of Kauai, 233 to 40 fathoms, station 3982 (type locality); northeast coast of Hawaii, 63 to 113 fathoms, stations 4062 and 4064. Cat. No. of type, 30549.

This species is nearest to *Nothocaris rostricrescentis* Bate, which is considerably larger, its rostrum curved more strongly upward, its sixth abdominal segment shorter.

Pandalus spinidorsalis, sp. nov.

(Pl. XXI, fig. 5.)

Near *P. bifurca* (Alcock and Anderson). Surface microscopically rugose. Rostrum from three-fourths to four-fifths as long as rest of carapace, gastric carina reaching two-thirds length of carapace, armed with $\frac{13}{4-6}$ spines, of which about 7–9 are on the carapace, the posterior spines smaller and closer. Telson as long as the fifth and sixth segments combined, the sixth short. Outer pair of terminal spines more than twice as long as inner pair. Ocellus indistinct. Antennular peduncle reaching about two-thirds the length of the antennal scale, the latter being half the length of the carapace proper. The outer maxillipeds reach end of acicle, while the first pair of legs reach as far as the distal third of the terminal joint of the maxilliped. They are provided with a minute dactylus but no chela. Of the second pair, the left leg is the longer and slenderer, with a carpus of thirteen to fourteen joints and reaches almost to end of maxilliped, while the right scarcely reaches end of antennal peduncle and has a five to six-jointed carpus. The third, fourth, and fifth pairs of feet diminish in the order named, the fourth being nearer the length of the third; the third exceeds the acicle by the dactylus and one-third of the propodus, while the fifth foot reaches middle of acicle; meral and carpal joints spiny below; succeeding joints setose.

Dimensions.—Female, station 3986, length (exclusive of movable spines of telson) 47, length of carapace 13.5, of rostrum 9.8, of abdomen 23, of telson 6.5, of sixth segment 3.8 mm.

This small species can be distinguished from most other species of *Pandalus* by the extension of the dorsal spines on the posterior half of the carapace.

Distribution.—Kaiwi Channel, 295 to 310 fathoms, stations 3467 and 3472; south coast of Oahu, 183 to 330 fathoms, stations 3813, 3914, and 3916; south coast of Molokai Island, 169 to 182 fathoms, station 3835; Pailolo Channel, 277 to 684 fathoms, stations 3868, 3883, 3899, and 3900; vicinity of Kauai Island, 55 to 362 fathoms, stations 3984, 3986 (type locality), 3998, 4001, 4130, and 4132; west coast of Hawaii Island, 147 to 232 fathoms, stations 4045 and 4047; north coast of Maui Island, 202 to 253 fathoms, stations 4081 and 4083; northwest coast of Oahu Island, 241 to 282 fathoms, stations 4116 and 4117; northeast approach to Pailolo Channel, 290 to 286 fathoms, station 4095. Cat. No. of type, 30550.

Heterocarpus ensifer A. Milne Edwards.

(Pl. XXI, fig. 7.)

Heterocarpus ensifer A. Milne Edwards, Ann. Sci. Nat., Zool. (6), XI, 1881, art. 4, p. 4; Rec. Pl. Expéd. Travailleur, pl. XXVII, 1883. Bate, Challenger Macrura, 638, pl. CXII, fig. 4, 1888. Borradaile, Stomatopoda and Decapoda of Willey's Exped., p. 413. Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 107, 1901.

?Pandalus carinatus Smith, Bull. Mus. Comp. Zool., X, 1882, 63, pl. X, figs. 2–2f and pl. XI, figs. 1–3.

Heterocarpus carinatus Wood-Mason, Ann. Mag. Nat. Hist. (6), IX, 1892, 369.

The specimens which have been referred to this species by different authors vary much in the dorsal surface of the first two abdominal segments. Bate describes and figures a low, thick carina on these segments, Alcock has the first carina faint, the second sharp, while according to Smith his *P. carinatus* has the segments evenly rounded above. A. Milne Edwards does not mention those segments, but in a fair-sized specimen from the Caribbean Sea (station 2359, *Albatross*) there is a feeble blunt carina visible on both segments. The Hawaiian form resembles the typical or West Indian in this regard. The carinæ of the third and fourth segments are more prominent and their posterior spine longer.

This is one of the most abundant of the deep-water shrimps taken about the Hawaiian Islands.

Distribution.—Kaiwi Channel, 220 to 375 fathoms, stations 3467, 3470, 3471, 3472, 3474, 3475, 3476, 3893, 4105, and 4106; south coast of Oahu Island, 42 to 337 fathoms, stations 3810, 3811, 3813, 3814, 3815, 3817, 3818, 3909, 3910, 3911, 3912, 3914, 3917, 3918, 3919, and 3920; south coast of Molokai Island, 259 to 266 fathoms, station 3839; Pailolo Channel, 31 to 290 fathoms, stations 3865, 3866, 3867, 3883, 3884, 3898, 3899, 3900, and 3901; vicinity of Laysan Island, 264 to 351 fathoms, stations 3952 and 3953; vicinity of Kauai Island, 55 to 469 fathoms, stations 3986, 3988, 3998, 4001, 4016, 4017, 4130, 4131, 4132, 4134, 4135, and 4136; west coast of Hawaii Island, 382 to 253 fathoms, station 4041; north coast of

Maui Island, 178 to 267 fathoms, stations 4080, 4081, 4082, 4083, and 4084; northeast approach to Pailolo Channel, 272 to 290 fathoms, stations 4095, 4096, and 4097; northwest coast of Oahu Island, 195 to 282 fathoms, stations 4115, 4117, 4120, and 4121; southwest coast of Oahu Island, 352 to 357 fathoms, station 4123.

Color.—Carapace translucent, showing anatomy, dark dirty crimson lake in front, very pale behind. Abdomen pale rose madder pink. Swimmerets and thoracic legs bright Chinese vermilion tending to carmine. Eyes black, iridescence yellow.

Heterocarpus lævigatus Bate.

Heterocarpus lævigatus Bate, Challenger Macrura, 636, pl. CXII, fig. 3, 1888; Anderson, Ann. Mag. Nat. Hist. (7), III, 1899, 285. Illus. Zool. Investigator, Crust., pl. XLII, figs. 1, 1a, 1899. Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 105, 1901.

The Hawaiian specimens show the following variations from the description of Alcock (loc. cit.): In four of the largest specimens, regardless of sex, the rostrum is shorter than the carapace. In many cases there are seven dorsal teeth, including the one or two on the rostrum; in one specimen there are eight teeth.

Dimensions of largest specimen, an egg-bearing female: Length of rostrum, 40 mm.; of carapace, 48.5 mm.; of abdomen, 91 mm.

Distribution.—Kaiwi Channel, 314 to 460 fathoms, stations 3470, 3474, 3475, 4105, 4106, 4109, 4110, 4112, and 4113; Pailolo Channel, 256 to 311 fathoms, stations 3865 and 3901; south coast of Oahu Island, 308 to 337 fathoms, stations 3909 and 3910; French Frigate Shoal, 395 to 397 fathoms, station 3973; vicinity of Kauai Island, 165 to 632 fathoms, stations 3988, 3992, 4013, 4021, 4028, 4137, and 4141; southwest coast of Oahu Island, 357 to 350 fathoms, station 4124; vicinity of Niihau Island, 319 to 426 fathoms, stations 4178 and 4179.

Heterocarpus signatus, sp. nov.

(Pl. XXI, fig. 6.)

This species is represented by only two small and soft-shell specimens, which resemble the young of *H. vicarius* Faxon.

Rostrum a little longer than carapace. Dorsal crest reaching nearly to posterior margin, armed with six large spines followed anteriorly by six or seven small ones; four or five spines on the carapace proper, the posterior one at its middle. Lower margin with ten small spines. Upper lateral carina of carapace much straighter than in *H. vicarius;* a very short carina leading from the antennal spine; the branchiostegal spine much longer and more advanced than the antennal, and its carina extending two-thirds the length of the carapace. Abdomen similar to that of *H. vicarius*, only the third segment being crested and that bluntly; at the posterior third of the crest in both specimens a small, oval depression resembling a scar. The inner branch of the uropods is distinctly longer than the telson; in *H. vicarius* just as long. Acicle nearly two-thirds length of carapace, longer than in *H. vicarius*, the antennular peduncle extending no farther than the middle of it. Maxilliped provided with an exopod and reaching nearly to end of acicle. The first pair of feet reach to same point and have a microscopic dactylus. The second foot on the right extends nearly to end of antennal peduncle, its carpus with eight joints. The second foot on the left extends beyond the peduncle by the length of the chela and three segments of the carpus, which has twenty-one joints. The third foot exceeds the acicle by length of its dactylus and two-fifths of the propodus; the fifth foot just attains end of acicle. These legs are considerably longer in *H. vicarius.*

Dimensions.—Largest specimen, length of carapace 12.8 mm., of rostrum 13.5 mm., of abdomen 25 mm.

Type locality.—West coast of Hawaii Island, 382 to 253 fathoms, station 4041 (Cat. No. 30551).

Heterocarpus alexandri A. Milne Edwards.

Heterocarpus alexandri A. Milne Edwards, Rec. Pl. Expéd. Travailleur, pl. XXVIII, 1883.

Vicinity of Kauai Island, 811 to 671 fathoms, station 4181; one specimen.

Family ATYIDÆ.

Atya bisulcata (Randall).

Atyoida bisulcata Randall, Jour. Acad. Nat. Sci. Phila., VIII (1839) 1840, 140, pl. v, fig. 5. See Bouvier, Comptes Rendus Acad. Sci. Paris, CXXXVIII, 1904, 446, and Ann. Mag. Nat. Hist. (7), XIII, 1904, 377.

Distribution.—Kaiwiki, Hilo, Hawaii, 1,800 feet altitude, 3 miles from sea, H. W. Henshaw. Pepeekeo, 10 miles from Hilo, H. W. Henshaw; "fresh-water rivulet directly over the sea but having no connection with it." Lahaina, Maui, U. S. Fish Commission; "fresh-water stream in canyon 5 miles east of Lahaina, April 12, 1902; inhabits a cool, swift mountain stream and is found back under the rocks, usually where there is a little fall. Species common."

Hawaiian Islands (Randall). Fragments of type in Museum of Philadelphia Academy of Natural Sciences. Hawaii (Stimpson). Oahu (Dana, Sharp). Honolulu (Bate).

Color "mottled grayish olive, tinges of red on lateral lappets of carapace."

Ortmannia henshawi Rathbun.

Atya bisulcata Sharp, Proc. Acad. Nat. Sci. Phila., 1893, 111 (part, Cat. No. 162).
Atyoida bisulcata Ortmann, Proc. Acad. Nat. Sci. Phila., 1894, 407.
Ortmannia henshawi Rathbun, Bull. U. S. Fish Com , XX, 1900, 2, 120, 1901.

An atavic form of *Atya bisulcata*. (See Bouvier, loc. cit.)

Distribution.—Kaiwiki, Hilo, Hawaii, 1,600 to 1,800 feet altitude, 3 to 5 miles from the sea, H. W. Henshaw. Pepeekeo, 10 miles from Hilo (with the preceding). Hilo, R. C. McGregor. Mountains of West Maui, near Wailuku, Iao Valley, 100 feet altitude, R. C. McGregor. Lahaina, Maui (with the preceding species).

Caridina brevirostris Stimpson.

Caridina brevirostris Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 29 [98].

A small species, length about 13.4 mm.

Rostrum short, triangular, sharp-pointed, not reaching end of first antennular segment. No antennal spine on carapace. Eyes transversely placed, scarcely exceeding peduncle of antennulæ. Antennular segments very short, second shorter than first, third shorter than second; basal scale reaching end of first segment. Antennal peduncle extending to end of second antennular segment; scale oblong, its outer spine more advanced than the antennular peduncle. Wrist of first pair of feet shorter than propodus and attached near middle of palm. Wrist of second pair as long as propodus and nearly as long as merus and ischium together, widening distally, extremity hollowed out similar to that of the first pair. Chelæ of both pairs very broad and similar; fingers shorter than palm, tips transparent, fringed with stout hair.

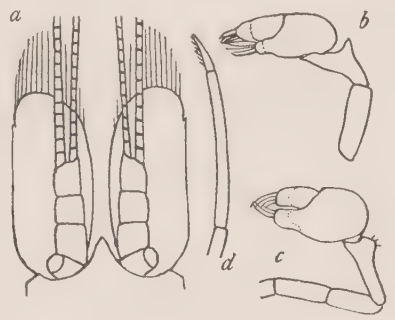

FIG. 67.—*Caridina brevirostris*, Puako Bay. *a*, Antennal region, much enlarged. *b*, First foot, × 16. *c*, Second foot, × 16. *d*, Portion of one of last three pairs, × 16.

"Color vermilion."

Distribution.—Five miles south of Puako Bay, Hawaii, July 13, 1902; "taken in small fresh or slightly brackish water pools in lava flow, near sea. The shrimps were found in some numbers on the rocks in the bottom of these pools." Hilo, Hawaii, H. W. Henshaw.

I have referred these specimens to the species which Stimpson describes very briefly from Loo Choo, although I have seen no other specimens.

In the hollowing of the carpus of the second foot, the species approaches the genus *Ortmannia*.

Family PONTONIIDÆ.

Harpilius depressus Stimpson.

(Pl. XXIV, fig. 12.)

Harpilius depressus Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 38 [107].
Anchistia spinigera Lenz, Zool. Jahrb., Syst., XIV, 1901, 434 (?*A. spinigera* Ortmann).

Honolulu, 1901; reef in front of Honolulu, 1901; Waikiki Beach, 1901.

Island of Hawaii among madrepores (Stimpson). Laysan (Lenz).

Rostral formula in our specimens $\frac{6-7}{4}$. Rostrum deeper than in Savigny's figure of *H. beaupresi* Audouin. Telson with either one or two pairs of dorsal aculei.

The antepenult joint of the third maxilliped is much narrower than in *H. lutescens* Dana; the terminal joint of the second maxilliped is suboval and articulated at the end of the penult joint. In these respects, it approaches the genus *Anchistus* Borradaile.

FIG. 68.—*Harpilius depressus*, Honolulu, 1901, rostrum, × 4⅝.

Coralliocaris quadridentata, sp. nov.

(Pl. XXIV, fig. 1.)

Body subcylindrical. Rostrum laterally compressed, narrow, reaching just to end of first antennular segment, directed slightly downward, armed above with four teeth, below entire. A strong spine at outer angle of orbit. Eyes stout, reaching about three-fourths length of rostrum. Second and third antennular segments very short, together shorter than the first, which has an outer distal spine. Antennal scale reaching to end of second antennular segment, blade rounded and fringed with hair, outer spine small and less advanced; peduncle reaching to end of first antennular segment; flagellum at least half as long as body.

Antepenult segment of third maxilliped only a little wider than the following joints and nearly as long as their combined length. First pair of feet as long as antennules; carpus equal in length to merus; propodus two-thirds of carpus; palm and fingers subequal. Second pair very unequal, but similar in form. Right or larger nearly as long as body; carpus very short, triangulate; propodus very stout, palm twice as long as high, crossed transversely by very fine rugæ; fingers about one-third as long as palm; pollex curved, with two basal teeth on prehensile edge; dactyl strongly enlarged distally, a deep sinus near the base. Left cheliped only about half as long as body and correspondingly narrow; dactylus more orbicular. Dactyli of last three pairs short, curved, thickened at base, and with an accessory spinule. Telson with two pairs of lateral spinules.

FIG. 69.—*Coralliocaris quadridentata*, type, rostrum, × 17⅜.

A small species, measuring 10 mm. long.

One specimen only from Auau Channel, 28 to 43 fathoms, station 3876 (Cat. No. 30552).

This species comes nearest to *C. tridentata* Miers, but the eyes are longer, the palm is not carinated below, and the pollex is dentate.

Coralliocaris truncata, sp. nov.

(Pl. XXIV, fig. 2.)

Body shaped as in the preceding (*C. quadridentata*). Rostrum half as long as carapace, reaching barely to end of antennular peduncle; inclined slightly downward; superior crest armed with six small spines, the first and second separated by the greatest distance; extremity truncate, armed with three small spines, one of which is the terminal one of the upper margin; in dorsal view rostrum broad at base, flanked on either side by a strong supra-ocular spine. A strong antennal spine also. Eyes very stout, cylindrical. Second and third joints of antennular peduncle very short, subequal, and together not so long as the first; flagella short. Antennal peduncle reaching end of first antennular segment; scale extending with about one-third its length beyond antennular peduncle, very broad, outer margin straight, inner very convex, antero-external spine very slender and exceeding the blade. Two last joints of third maxilliped distinctly narrower than antepenult joint, and together about equaling the

latter. First pair of chelipeds very slender; if extended, the chela would overreach the acicle; merus and carpus subequal in length, chela three-fourths as long as carpus, palm and fingers subequal. Legs of second pair stout, extending beyond the acicle by the chela and half the carpus; merus of right or larger foot nearly as high as long, two small teeth on the outer distal margin; carpus cyathiform, distal margin very thin; propodus a little more than twice as long as wide, inner margin nearly straight; outer convex, surface granulate; fingers about two-thirds as long as palm, with a few teeth on prehensile margin. Left cheliped similar except for smaller size; fingers slenderer and longer than palm, edges subentire.

FIG. 70.—*Coralliocaris truncata*, type, rostrum, × 20.

The dactylus of the remaining legs is short, broad at base, and has a supplementary spine. Telson one and two-thirds times as long as sixth segment, with two pairs of longish lateral spines, and three pairs of terminal spines, of which the intermediate pair are half as long as the segment.

Length 8.5 mm., carapace 3.5 mm.

South coast of Molokai Island, 23 to 24 fathoms, station 2847, one specimen (Cat. No. 30553).

Periclimenes pusillus, sp. nov.

(Pl. XXIV, fig. 7.)

A small *Periclimenes* very close to *P. parvus* Borradaile,[a] but differing as follows:

The rostrum is as long as, not shorter than, the carapace; its upper outline is ascending before descending; dental formula, in the four specimens, $\frac{6}{2}$ instead of $\frac{6}{1}$. The carapace has a short antennal, but no hepatic spine. The second pair of feet overreach the antennal scale by the length of the propodite, as in the figure of *P. parvus*. The dactyli of the third to fifth pairs are shorter and uniunguiculate. Otherwise the description of *P. parvus* applies to this species.

Four specimens, each about 9 mm. long, from south coast of Oahu, surface, station 3921 (Cat. No. 30554).

FIG. 71.—*Periclimenes pusillus*, type, rostrum, × 12.

Periclimenes, sp.

Distribution.—South coast of Molokai Island, 23 to 24 fathoms, station 3847; vicinity of Kauai Island, 68 to 179 fathoms, station 4128.

Two specimens lacking rostrum and feet of second pair do not agree entirely with any species described, but come nearest to *P. ensifrons* (Dana), from which they differ chiefly in the greater length of the feet of the first pair, which in the smaller example exceed the antennal scale by the length of the chela and half the carpus, in the larger example by length of chela and nearly whole of carpus. Length of larger specimen, station 3847, without rostrum, 10.5 mm.

Family OPLOPHORIDÆ.

Oplophorus gracilirostris A. Milne Edwards.

Oplophorus gracilirostris A. Milne Edwards, Ann. Sci. Nat., Zool. (6), XI, 1881, Art. 4, p. 6; Recueil Planches Exped. "Travailleur," pl. xxx, 1883.

Hoplophorus gracilirostris Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 73, 1901, and synonymy.

Distribution.—Kaiwi Channel, 295 to 433 fathoms, stations 3470, 3472, 4105, and 4113; south coast of Oahu Island, 228 to 322 fathoms, stations 3815, 3908, 3909, 3914, 3918, and 3920; south coast of Molokai Island, 222 to 498 fathoms, station 3824; Pailolo Channel, 256 to 284 fathoms, stations 3865 and 3899; vicinity of Kauai Island, 257 to 326 fathoms, stations 3990, 4130, and 4131; northeast approach to Pailolo Channel, 306 to 308 fathoms, station 4092; northwest coast of Oahu Island, 282 to 253 fathoms, station 4117.

Color.—Bright carmine pink.

[a] Ann. Mag. Nat. Hist. (7), II, 1898, 384; Willey, Zool. Results New Britain, etc., Pt. IV, 407, pl. XXXVI, figs. 3*a*–3*c*, 1900.

Oplophorus foliaceus, sp. nov.

(Pl. xx, fig. 8.)

Rostrum slender, upcurved, one and a half times as long as the rest of the carapace, produced as a sharp carina to the posterior border of the carapace; with $\frac{1}{3}^{1}$ teeth; its sides continued back by a very short post-orbital carina. No tooth at post-lateral angle of carapace. Second, third, and fourth abdominal segments terminating in a spine, that of the second segment much the longest.

In the female the pleuron of the first segment is oblong, not incised; of the second longer than high; of the third to fifth segments broadly rounded, not toothed. Telson longer than caudal swimmerets, armed with three spinules on each side, followed by a very long spine. Antennular peduncle with basal joint the longest; flagella nearly as long as rostrum. Antennal scale the length of carapace; four serrations on outer margin. Outer maxillipeds similar to those of *O. gracilirostris*. Second pair of feet a little shorter than first pair. Third pair longer than maxillipeds by length of last article, this article in both third and fourth pairs longer than the propodus; lower border of ischium and merus spined. The exopods of all the trunk legs are foliaceous, but not rigid; those of fifth pair much reduced in length. The two females carry nine and ten large oval eggs, respectively.

FIG. 72.—*Oplophorus foliaceus*, station 4108. *a*, Telson, × 3⅛. *b*, Exopod of second foot (enlarged).

Dimensions.—Ovigerous female, length of carapace 8.4, rostrum 13.8, abdomen 32, greatest diameter of egg 2.5 mm.

Distribution.—Kaiwi Channel, 337 to 442 fathoms, stations 3471 (type locality), 1 female (Cat. No. 30555), and 4108, 1 female.

This species differs from all previously described in having a long spine on the second abdominal tergum, and in the foliaceous exopods of all the trunk legs.

Acanthephyra eximea Smith.

Acanthephyra eximea Smith, Rept. U. S. Fish Commr. for 1882, p. 376 (1884); Rept. for 1885, 667, pl. xiv, fig. 1 (1886).

Acanthephyra eximia Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 76, 1901 and synonymy.

Distribution.—North coast of Molokai Island, 552 to 809 fathoms, station 3887; vicinity of Modu Manu, 876 to 1,059 fathoms, stations 3977 and 4153; vicinity of Kauai Island, 339 to 773 fathoms, stations 3985, 4004, 4005, 4018, 4019, 4028, 4029, 4137, 4140, 4141, and 4187; Kaiwi Channel, 433 to 470 fathoms, stations 4110, 4111, and 4112.

In these specimens the rostral spines are $\frac{5\text{-}6}{3\text{-}4}$, except in the large individual from station 3887, where they are $\frac{4}{0}$, the rostrum not reaching end of acicle and its terminal half unarmed. The spine of the third abdominal segment reaches about to the middle of the fourth segment as in the type.

Color.—Bright carmine, nearly uniform; or scarlet vermilion.

Acanthephyra debilis A. Milne Edwards.

Acanthephyra debilis A. Milne Edwards, Ann. Sci. Nat., Zool. (6), XI, 1881, Art. 4, p. 13. Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 163.

Miersia gracilis Smith, Bull. Mus. Comp. Zool., X, 1882, 70, pl. xi, figs. 4–4d.

Acanthephyra debilis var. *Europaea* A. Milne Edwards, Rec. Pl. Travailleur, pl. xxxiii, 1883.

Acanthephyra gracilis Smith, Rept. U. S. Fish Commr. for 1882, 672 (1884).

Vicinity of Kauai Island, 478 to 453 fathoms, station 4029; one specimen.

Family PALÆMONIDÆ.

Bithynis grandimanus (Randall).

(Pl. XXII, fig. 5.)

Palemon grandimanus Randall, Jour. Acad. Nat. Sci. Phila., VIII, 1839 (1840), 142.

Palemon gracilimanus Randall, op. cit., p. 143.

Palæmon grandimanus Dana, Crust. U. S. Expl. Exped., I, 588, 1852; pl. XXXVIII, fig. 12a–b, 1855; Ortmann, Zool. Jahrb., Syst., V, 1891, 736 and 740. Lenz, Zool. Jahrb., Syst., XIV, 1901, 436, pl. XXXII, figs. 4 and 5.

Palæmon acutirostris Dana, op. cit., p. 590, 1852; pl. XXXIX, fig. 1a, a′, b, 1855. Streets, Bull. U. S. Nat. Mus., No. 7, 1877, 119.

Bithynis grandimanus Bate, Challenger Macrura, 793, pl. CXXIX, figs. 2 and 3, 1888.

Notes on the type specimens.—Hawaiian Islands, type locality (Randall). Two male specimens collected by Messrs. Nuttall and Townsend are preserved in the Museum of the Philadelphia Academy of Natural Sciences. They are 67 and 63 mm. in length. Both claws of the smaller specimen are extant, but only the smaller claw of the larger specimen; in both, the rostral teeth number $\frac{1}{4}^{5}$. Rostrum a little less than two-thirds the length of rest of carapace, not reaching end of acicle; dorsal crest convex, extending backward one-third the length of the carapace. Body stout; antennal tooth strong; hepatic tooth (or one behind antennal) very small in comparison; antero-lateral angle rounded, unarmed. Telson with two pairs of dorsal spinules; a spiniform median tip, outside of which are two pairs of movable spines, the inner pair long and stout and extending half their length beyond the median spine; the outer pair small and reaching only half as far as median spine; underneath the latter is a bunch of long bristles which reach as far as the longest spines.

Acicle oblong, truncate, outer spine not exceeding blade. Merus of first pair of feet reaching just to end of antennal peduncle; carpus, when extended, to end of acicle; chela slightly more than twice length of carpus.

The larger claw is 80 mm. long, the smaller one on same individual 43 mm. long. Carpus of larger claw a little longer than merus, increasing in diameter to the distal end; manus one and a half times as long as carpus, compressed; greatest width a little more than one-third length, upper margin convex, forming a single curve to the end of the dactylus; this last slender, nearly as long as palm, strongly curved down, prehensile teeth irregular, the largest at the middle, three somewhat smaller near the base; pollex broken off near its base. Carpus of smaller claw has same shape and same length in relation to its merus as in the larger claw; palm a little over two-thirds as long as the carpus, compressed but not dilated, only a little more than twice as long as wide. Dactylus two and a third times as long as palm; both fingers slender and curved so that their concave surfaces are presented to each other, tips crossing; fingers furnished along their prehensile edges with long bristles. Both claws rough with spinules and hairy.

Remaining appendages a good deal broken, but the feet of fourth pair reaching to distal fourth of acicle.

The types of *P. gracilimanus* Randall (op. cit., p. 143), from the Hawaiian Islands, were not to be found in the museum of the Philadelphia Academy June 17, 1904, although noted by Sharp in 1893. I think it is probable that this species is synonymous with *P. grandimanus*, and represents a variation.

Distribution.—Taken by the Fish Commission in 1901 at Waianae, Oahu; Opae Oehaa; Hilo; Honolulu; run at Mauna Loa; Heeia; Kaneoke Cove, Heeia; in 1902 at Hanalei River at Hanalei, Kauai; Hauapepe River, Kauai; Huleia River, Nawiliwili, Liliue district, Kauai; Waimea River, Kauai; Honolulu market.

Oahu, Dr. T. H. Streets, U. S. Navy; Hilo, Hawaii, H. W. Henshaw; Waiakla River, near Hilo, H. W. Henshaw.

Hawaiian Islands (Dana, Streets). Honolulu (Bate); a few specimens taken by the *Challenger* are in the U. S. National Museum. Kalihi, Oahu (Lenz).

Very young specimens have the rostrum concave above, the tip slender and inclined upward; with age the rostral crest becomes more convex for its posterior two-thirds and toward the tip may be horizontal or even inclined downward.

P. acutirostris as figured by Dana represents a female. There are egg-laden females only 39 mm. long in the Fish Commission collection.

Hippolyte gracilipes Randall (Proc. Acad. Nat. Sci. Phila., 142, 1840), according to Gibbes (Proc. Amer. Assoc. Adv. Sci., III, 1850, 197 [33]) is a *Palæmon;* Sharp, in his list of Macrura in the Museum of the Philadelphia Academy (Proc. Acad. Nat. Sci. Phila., 1893, 115–117) does not mention *Hippolyte gracilipes.* I did not find the type in the summer of 1904.

Palæmon debilis Dana.

(Pl. XXII, fig. 1.)

Palæmon debilis Dana, Crust. U. S. Expl. Exped., I, 585, 1852; pl. XXXVIII, fig. 6, 1855.
Palæmon debilis var. *attenuatus* Dana, op. cit., 585, pl. XXXVIII, fig. 7.
Leander debilis Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 40 [109]. Ortmann, Zool. Jahrb., Syst., V, 1890, 515. Lenz, Zool. Jahrb., Syst., XIV, 1901, 435.

Rostral formula $\frac{4-6}{7-10}$, tip bifid; terminal half unarmed above. Sixth abdominal segment two-thirds as long as carapace. Carpus of second pair of feet longer than propodus.

Taken by the Fish Commission in 1901, at Opae; Mauna Loa in coral pools; Pearl Harbor; in 1902, at Honolulu Reef; Kealakekua Bay, Hawaii; Puako Bay, Hawaii; south coast of Molokai Island, station 3844. Hilo, Hawaii, H. W. Henshaw.

Hawaiian Islands (Dana, Stimpson); var. *attenuatus,* Hilo (Dana). Lahaina, Maui, brackish pond; Oahu; Kaliki, fresh water lake, Oahu (Lenz). Oahu (Sharp).

Palæmon pacificus (Stimpson).

(Pl. XXII, fig. 3.)

Leander pacificus Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 40 [109]. Ortmann, Zool. Jahrb., Syst., V, 1890, 515.

Less abundant than the preceding. Rostral formula $\frac{7-8}{4-5}$, tip obliquely trifid; sometimes the accessory subterminal teeth rather remote from tip, so that there appear to be nine or ten dorsal teeth. Sixth abdominal segment half as long as carapace. Carpus of second pair of feet shorter than propodus.

Taken by the Fish Commission in 1901 off pier, Moana Hotel, in 1902 at Honolulu Reef and at Hilo. Hilo, Hawaii, H. W. Henshaw.

Hawaii (Stimpson).

Palæmon pandaloides, sp. nov.

(Pl. XXII, fig. 4.)

Median carina extending halfway back on the carapace. Rostrum from one and a half to nearly twice as long as rest of carapace; slender, ascending; armed above with seventeen movable overlapping spines, of which five are behind the orbit, the remainder on the basal two-fifths of the rostrum, distal portion unarmed above except for subterminal spine; thirteen fixed spines below, which diminish in size distally, the last one remote from tip.

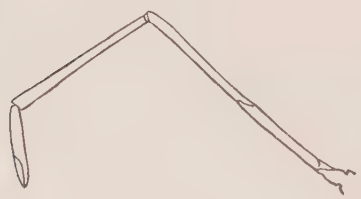

Fig. 73.—*Palæmon pandaloides,* type, foot of second pair, × 3⅛.

A long antennular spine and a somewhat shorter antennal spine on the anterior margin of carapace. Sixth pleonic segment twice as long as fifth, and nearly as long as telson, which has two pairs of lateral spines.

No distinct ocellus on the eye. Antennular peduncle extending to middle of antennal scale; basal spine overlapping second segment a little, third segment slightly shorter than second; flagella at least as long as rostrum. Basal segment of antenna with an outer distal spine; scale nearly as long as carapace, extremity very oblique, outer spine less advanced than end of blade; peduncle reaching just to end of second segment of antennular peduncle. Outer maxillipeds very slender, exceeding antennal peduncle by over half the terminal segment.

The first pair of trunk feet reach to distal third of acicle, carpus one and a half times merus, enlarged distally; propodus same length as merus, not larger than distal end of carpus, fingers half as long as palm. The left foot of the second pair exceeds the scale by the length of half the propodus; it is similar in form and thickness to the first; merus three-fourths as long as carpus, which is twice as long as propodus; palm twice as long as fingers. The right foot of second pair in type specimen is missing, but the basal joint appears somewhat stouter than that of the left foot. Both feet of second pair are missing from second specimen. The third foot reaches end of acicle, the fifth extends only to distal third of acicle; in the second specimen these feet are a little longer.

Dimensions.—Male, length of carapace, 9.5; rostrum, 15.7; abdomen, 31 mm.

Vicinity of Kauai Island, 528 fathoms, station 3992; 1 male, 1 female (Cat. No. 30556).

This species in its long rostrum and acicle has great resemblance to a *Pandalus*.

Palæmonella tenuipes Dana.

Palæmonella tenuipes Dana, Crust. U. S. Expl. Exped., I, 582, 1852; atlas, pl. XXXVIII, fig. 3 a–d, 1855.

South coast of Molokai Island, 8 fathoms, station 3834, one specimen about 11 mm. long, rostral formula $\frac{7}{2}$; second pair of feet as long as body exclusive of rostrum.

One imperfect specimen of *Palæmonella* from northeast coast of Hawaii Island, 77 to 75 fathoms, station 4057, has much resemblance to *P. tridentata* Borradaile.[a] The rostrum and antennal joints are similar; rostral formula $\frac{8}{3}$, rostrum more ascending. Only feet of the first and fourth pairs are present, both very slender, the fingers of the first pair thin, blade-like, and quite as long as the palm. The outer uropod is longer than the inner.

Palæmonella orientalis Dana.

Palæmonella orientalis Dana, Crust. U. S. Expl. Exped., I, 583, 1852; atlas, pl. XXXVIII, fig. 4 a–d, 1855.

South coast of Oahu, surface, stations 3812 and 3921; north coast of Molokai, surface, station 3889. Four specimens in all.

This species has a hepatic as well as an antennal spine; it is not shown in Dana's figure, but in his description of the genus (p. 582, op. cit.) he says: "In both species of the genus here described the carapax has two spines below the eye in nearly the same horizontal line."

The rostral formula in our specimens is $\frac{6-7}{3}$, with one spine behind the orbit; in Dana's type $\frac{6}{1}$.

In the second pair of feet the carpus is shorter than half the propodus, not shorter than half the palm, and the fingers are nearly or quite as long as the palm. The last three pairs of feet have biunguiculate dactyli, as in *P. biunguiculata* Nobili.

Palæmonella laccadivensis Alcock and Anderson.

(Pl. XXII, fig. 2.)

Palæmonella laccadivensis Alcock and Anderson, Jour. Asiatic Soc. Bengal, LXIII, 1894, 157; Ann. Mag. Nat. Hist. (7), III, 1899, 4; Illus. Zool. Investigator, Crust., part IV, pl. XXVI, fig. 4, 1896.

Vicinity of Kauai Island, 500 to 385 fathoms, station 3989, 1 female. The rostrum is longer than in the type, exceeding the acicle, and has thirteen instead of nine spines above, two of them being behind the orbit, and three spines below instead of two. Length, 33.2 mm.

Vicinity of Laysan Island, 222 to 100 fathoms, station 3943. One female laden with eggs is very much smaller than the preceding (15 mm. long); its rostral formula is $\frac{8}{2}$, the rostrum scarcely reaching beyond antennular peduncle.

[a] Proc. Zool. Soc. London, 1898, 1007, pl. LXIV, figs. 8–8c.

Family GNATHOPHYLLIDÆ.

Gnathophyllum fasciolatum Stimpson.

Gnathophyllum fasciolatum Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 97 [28].

Twelve small specimens, each about 7 mm. long, were taken at the surface at station 3921, south coast of Oahu Island. In alcohol they are colorless.

FIG. 74.—*Gnathophyllum fasciolatum*, station 3921, second foot, × 12.

The rostrum does not quite reach the end of the first antennular segment, and has five or six teeth above and a small one subterminal below.

The eyes are relatively larger than in *G. elegans* (Risso), the sixth abdominal segment more elongate, and the caudal spines not so near the extremity, the anterior pair being at the middle of the telson.

The palm of the second pair of chelipeds is one and a half times as long as the fingers.

An examination of more Indo-Pacific material might prove this to be a new species. Stimpson's description is too brief to permit of certain identification.

Family NEMATOCARCINIDÆ.

Nematocarcinus ensiferus (Smith).

Eumiersia ensifera Smith, Bull. Mus. Comp. Zool., X, 1882, 77, pl. XIII, figs. 1–9.

Nematocarcinus ensiferus Smith, Rept. Commr. Fish and Fisheries for 1882, 368 [24], pl. VII, fig. 1, 1884; Rept. Commr. Fish and Fisheries for 1885, 664 [60], pl. XVII, fig. 2, 1886.

Nematocarcinus tenuipes Bate, Challenger Macrura, 812, pl. CXXXII, fig. 6, 1888; Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 87, 1901.

Nematocarcinus ensifer Faxon, Mem. Mus. Comp. Zool., XVIII, 1895, 156.

The specimens are all rather small and the rostrum ranges from one-half in the larger to one-fourth in the smaller individuals of the length of the carapace, and the dorsal crest bears from twenty-three to twenty-six spines and one or none below.

Distribution.—Vicinity of Modu Manu, 293 to 1,059 fathoms, stations 4153 and 4166; vicinity of Niihau Island, 735 to 865 fathoms, station 4174; vicinity of Kauai Island, 1,000 to 1,314 fathoms, station 4185; 6 specimens in all.

Nematocarcinus tenuirostris Bate.

(Pl. XXIII, fig. 6.)

Nematocarcinus tenuirostris Bate, Challenger Macrura, 817, pl. CXXXII, fig. 10, 1898; Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 88, 1901.

This is the most abundant of the Hawaiian species of *Nematocarcinus*. The rostrum is from two-thirds to one-half as long as the rest of the carapace; in young specimens still shorter, between one-third and one-fourth of remainder of carapace. Rostrum usually horizontal, its lower margin straight as far as the subterminal spine; upper margin slightly convex, tip spiniform. Dorsal teeth nine to thirteen, from two to five behind the orbit, a few of the posterior teeth nearer together than the rest; ventral spines one or two.

Third abdominal tergum moderately produced and bluntly rounded; sixth twice as long as fifth.

The antennular peduncle reaches halfway along the acicle. The outer maxillipeds reach to or nearly to the distal fourth of the acicle. The first pair of feet exceed the acicle by length of chela and about one-fifth of carpus. The three last pairs are very elongate, being considerably longer than the body, and if extended would reach beyond the acicle by length of chela, carpus, and two-thirds of merus. A few distant spines arm the merus and distal end of ischium.

Color.—Bright pink.

This species, as Alcock has indicated, differs from *N. ensiferus* chiefly by the fewer rostral teeth and longer legs.

Distribution.—Kaiwi channel, 313 to 470 fathoms, stations 3470, 3473, 3474, 3475, 4106, 4108, 4109, 4110, 4111, 4112, and 4113; south coast of Molokai Island, 222 to 498 fathoms, station 3824; north coast of Molokai Island, 328 to 414 fathoms, station 3892; vicinity of Kauai Island, 165 to 881 fathoms, stations 3985, 3988, 3989, 3997, 4013, 4014, 4015, 4019, 4020, 4021, 4028, 4029, 4137, 4138, 4140, 4141, 4142, and 4187; between Honolulu and Kauai Island, 508 to 557 fathoms, station 4007; west coast of Hawaii Island, 382 to 253 fathoms, station 4041; vicinity of Modu Manu, 293 to 800 fathoms, station 4166; vicinity of Niihau Island, 672 to 417 fathoms, stations 4176 and 4180.

Although 275 specimens were taken, only a small number are provided with any legs.

Nematocarcinus gracilis Bate.

Nematocarcinus gracilis Bate, Challenger Macrura, 815, pl. CXXXII, fig. 8, 1888. Alcock, Desc. Cat. Indian Deep-Sea Crust. Dec. Macr. Anom., 90, 1901.

Rostrum one-third as long as carapace, teeth $\frac{16\text{-}22}{1}$, about seven of the dorsal spines on the carapace proper. Telson with its long terminal spines exceeds outer uropods. The antennular peduncle reaches a little beyond middle of acicle. Three-fifths of carpus of first pair of feet extend beyond acicle. Three hind pairs much longer than body, exceeding the latter by nearly one-fourth their length.

This species differs from *N. cursor* A. Milne Edwards much as *N. tenuirostris* Bate does from *N. ensiferus* (Smith); that is, in its more numerous and more closely set rostral teeth, and much longer legs.

Distribution.—South coast of Molokai Island, 430 to 371 fathoms, station 3826; north coast of Molokai Island, 295 fathoms, station 3904; south coast of Oahu Island, 294 to 330 fathoms, stations 3916 and 3917; French Frigate Shoal, 395 to 397 fathoms, station 3973; vicinity of Kauai Island, 165 to 703 fathoms, stations 3983, 3985, 3988, 3989, 3992, 4022, 4137, and 4187; Kaiwi Channel, 350 to 433 fathoms, stations 4107 and 4113.

Family STYLODACTYLIDÆ.

Stylodactylus discissipes Bate.

(Pl. XXIII, fig. 1.)

Stylodactylus discissipes Bate, Challenger Macrura, 851, pl. CXXXVIII, fig. 1, 1888.

Vicinity of Kauai Island, 230 to 53 fathoms, station 4002; 1 female.

The dimensions are as follows: Rostrum 9, carapace 6.6, entire length 33.3 mm.; antennal flagellum 66 mm. Rostral formula $\frac{3}{9}\frac{1}{1}$; the ventral teeth are at irregular intervals, as if the normal number were greater. Surface of carapace densely and finely punctate, and with a deciduous pubescence.

FIG. 75.—*Stylodactylus discissipes*, telson, × 4⅛.

Of the five pairs of lateral spines on the telson the posterior pair is almost in line with the posterior median spine; beneath the latter and across the end of the segment are two pairs of very long movable spines, of which the inner pair is three-fifths as long as outer pair.

Family PASIPHÆIDÆ.

Pasiphæa kaiwiensis, sp. nov.

(Pl. XXIII, fig. 4.)

Length of carapace contained in length of abdomen from two and two-thirds to two and four-fifths times. Carapace not carinate except at the anterior tooth, which is triangular, dentiform, with a spiniform tip, and does not reach the level of the anterior margin of the carapace. Branchiostegal spine situated over the anterior end of the branchiostegal sinus.

Abdomen not carinate; although the sixth segment is much compressed, it is very blunt and smooth above. Telson about three-fourths as long as sixth segment, its tip cut in a very shallow V.

Eyes considerably enlarged distally. Antennular peduncle reaching a little past middle of acicle, which is slightly more than half length of carapace.

The first two pairs of feet extend beyond acicle by about length of fingers; merus of first pair armed with one spine or none below; merus of second pair many-spined. Fingers of first pair subequal to palm; of second pair one and a half to one and two-thirds times as long as palm.

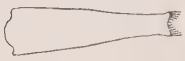

FIG. 76.—*Pasiphæa kaiwiensis*, station 3470, telson, × 2⅔.

Dimensions.—Ovigerous female, length of carapace 25.7, length of abdomen 74 mm.

Kaiwi Channel, 343 to 337 fathoms, stations 3470 (type locality) and 3471; 8 specimens. Cat. No. of type, 30557.

This species is strongly like *P. americana* Faxon, but differs most notably in its longer acicle, longer fingers, and less deeply cut telson.,

Pasiphæa truncata, sp. nov.

(Pl. XXIII, fig. 5.)

Differs from *P. kaiwiensis* in having the sixth abdominal segment sharply carinate, the carina terminating in a short, pointed tooth; in having the telson more deeply grooved and its tip truncate; in having the acicle just half as long as carapace; the merus of first pair of feet armed below with many spines; fingers about two-thirds as long as palm, those of second pair a little longer than palm.

There are also minor differences, such as the greater prominence of the median frontal lobe, the greater obliquity of the angle of the branchiostegal sinus.

FIG. 77.—*Pasiphæa truncata*, station 3474, telson, × 2⅔.

Dimensions.—Male (station 4166), length of carapace 24.5, length of abdomen 66 mm.

Distribution.—Kaiwi Channel, 351 to 375 fathoms, stations 3474 and 3475; vicinity of Modu Manu, 293 to 800 fathoms, station 4166 (type locality); 4 specimens. Cat. No. of type, 30558.

Pasiphæa flagellata, sp. nov.

(Pl. XXIII, fig. 2.)

Length of carapace contained little more than twice in length of abdomen. Carapace similar to that of *P. kaiwiensis;* median tooth farther back.

Abdomen with sixth segment bluntly carinate, and very slightly exceeding the telson, which is deeply grooved, and has the tip truncate aside from the movable spines.

FIG. 78.—*Pasiphæa flagellata*, station 4108, telson, × 2⅔.

Acicle less than half as long as carapace. Antennal flagellum very long (twice as long as body) and very fine in distal half. The two pairs of chelipeds exceed the acicle by the fingers and about one-fourth the palm. Fingers of first pair three-fourths as long as palm, of second pair a little longer than palm. Merus of first pair armed below with three or four, of second pair with many spines.

Dimensions.—Female (station 4108), length of carapace 24.6, of abdomen 53.2 mm.

Distribution.—North coast of Molokai Island, 295 fathoms, station 3904; vicinity of Kauai Island, 362 to 399 fathoms, stations 4014 and 4022; Kaiwi Channel, 411 to 442 fathoms, station 4108 (type locality); 6 specimens. Cat. No. of type, 30559.

P. flagellata, like the two preceding species, belongs to the same group as *P. americana* Faxon and *P. affinis* Rathbun, in which the carapace is not carinated, the gastric spine does not overreach the frontal margin, and the branchiostegal spine is anteriorly placed. It differs, however, in its truncate telson, from all of the group except *P. truncata;* from *P. americana* in its longer carapace and chelæ with proportionally longer fingers and its longer telson; from *P. affinis* in its noncarinated abdomen, except the sixth segment; from *P. kaiwiensis* and *P. truncata* in longer carapace, shorter acicle, etc.

Psathyrocaris hawaiiensis, sp. nov.

In the vicinity of Modu Manu in 876 fathoms, station 3977, was found a specimen of a species differing from any yet described. The specimen is much damaged and devoid of a large share of its appendages.

Rostrum nearly half as long as carapace, reaching beyond middle of second antennular segment; upper margin straight, armed with seventeen close-set spines above, of which only two are behind the orbit, the crest not being prolonged farther back, and five minute spinules below, this margin appearing unarmed to the naked eye; tip acuminate.

Eyes much flattened, as in *P. platyophthalmus*, Alcock and Anderson, showing only a narrow crescent of light-colored pigment.

The antennular scale overlaps a little the second segment, which is three times as long as the third; the peduncle reaches somewhat beyond middle of antennal scale; the antennal peduncle falls very little short of the antennular.

Outer maxilliped reaching to end of acicle. The only trunk-leg remaining is one of the third pair, and reaches to middle of acicle and has a falcate dactylus which is the same length as the propodus and more than twice as long as carpus.

The abdomen is too mutilated to show any distinctive character; none of the pleopods are perfect.

Length of rostrum 5.8, of carapace 11.5 mm.

Differs from other species in longer and more slender rostrum, longer second joint of antennula.

Cat. No. of type, 30560.

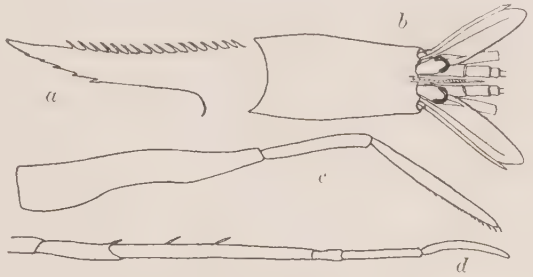

FIG. 79.—*Psathyrocaris hawaiiensis*, type. *a*, Rostrum, × 4. *b*, Carapace and antennal region, × 1½. *c*, Outer maxilliped, × 4. *d*, Third foot, × 4.

Leptochela robusta Stimpson.

Leptochela robusta Stimpson, Proc. Acad. Nat. Sci. Phila., XII, 1860, 112 [43]. Bate, Challenger Macrura, 862, pl. CXXXIX, figs. 3 and 4, 1888.

Distribution.—South coast of Oahu Island, surface, stations 3812 and 3921; south coast of Molokai Island, surface, station 3829.

These specimens average 13 mm. in length. Rostrum very slender, shorter than eyes. Longer antennular flagellum longer than carapace. Fifth abdominal segment very bluntly and obscurely carinate; sixth segment with a median tubercle at proximal end, which, however, is hidden under the preceding segment when the abdomen is horizontally extended. The three pairs of dorsal spines on the telson very remote from one another, one pair at middle, one very near distal end and the other very near proximal end.

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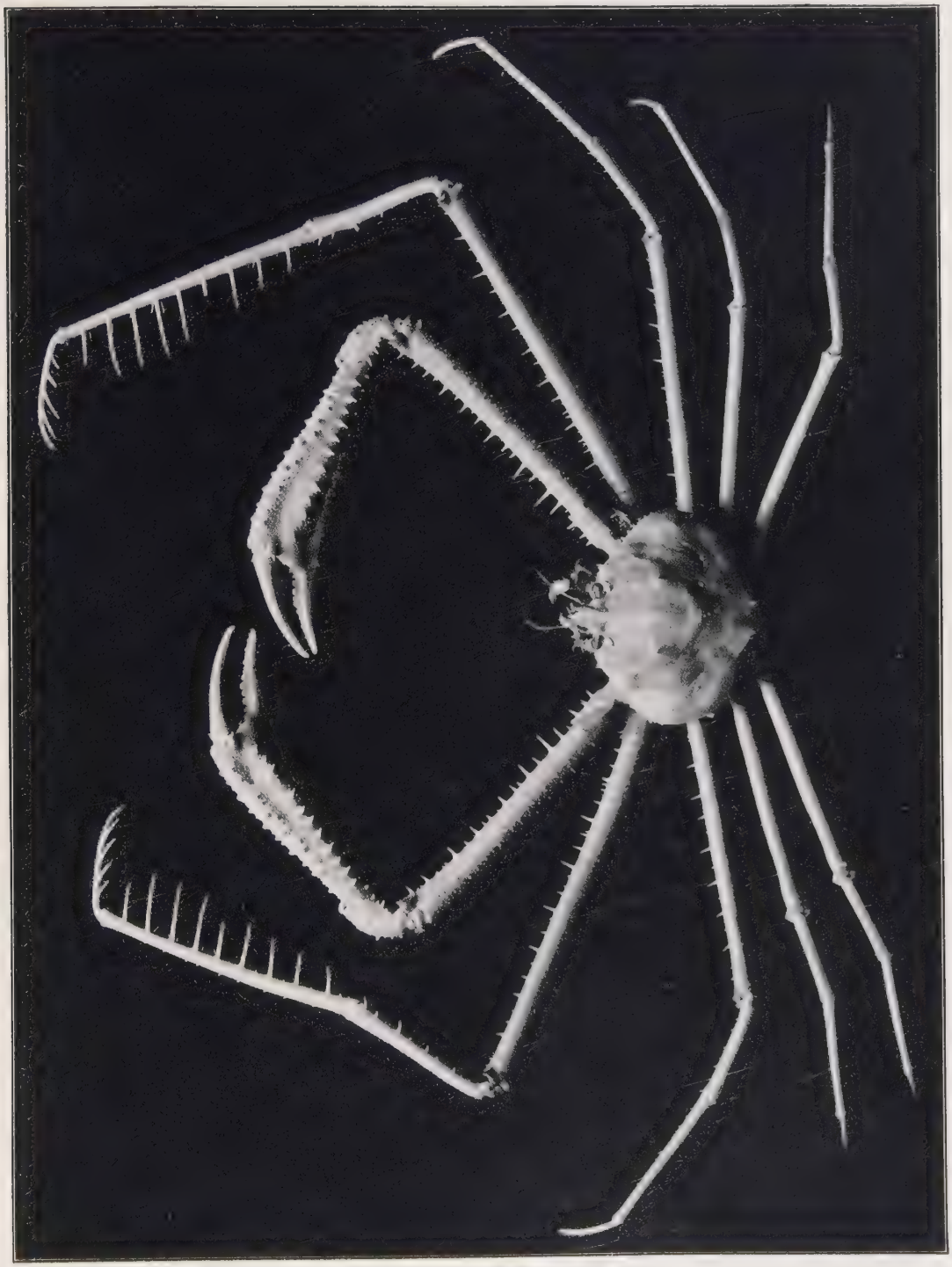
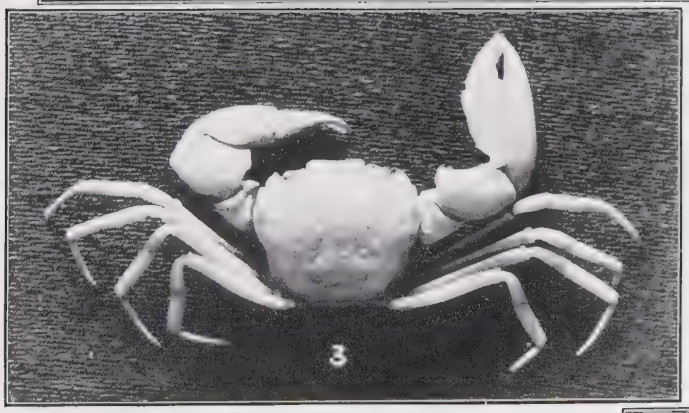
ETISUS SPLENDIDUS, SP. NOV.

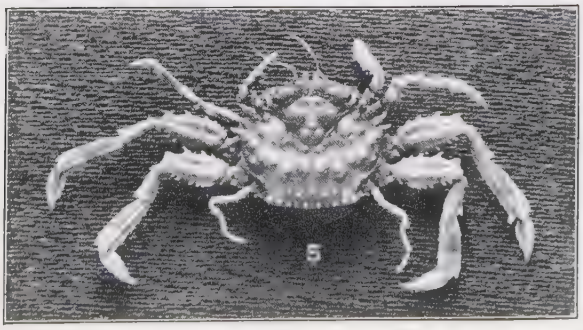
CHARYBDIS ERYTHRODACTYLA (LAMARCK).

PANULIRUS JAPONICUS (DE SIEBOLD).

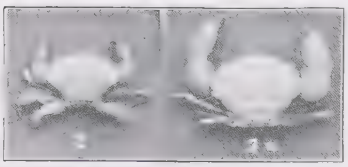


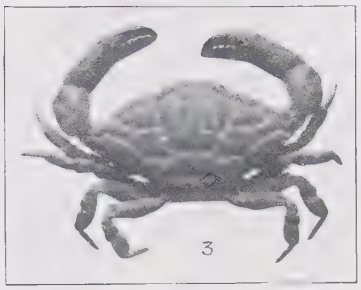
CYRTOMAIA SMITHI, MALE, STATION 3984.

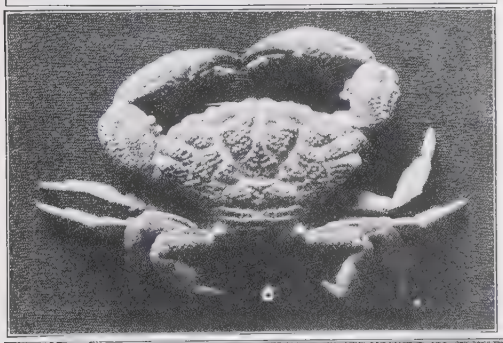




1. *Sarmatium fasoni*, female, type.
2. *Ocypode lævis*, male, Honolulu.
3. *Pilumnoplax cooki*, male, type.
4. *Pilicus oahuensis*, female, type
5. *Pilicus fisheri*, male, type.
6. *Manella spinipes*, male, station 3847



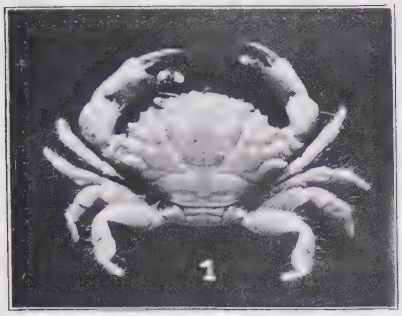


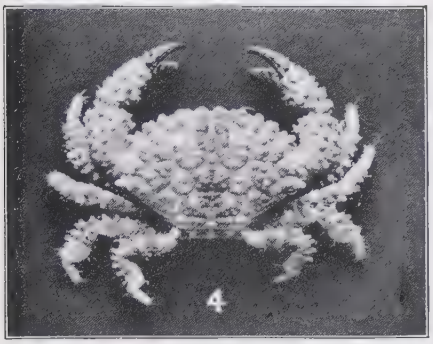


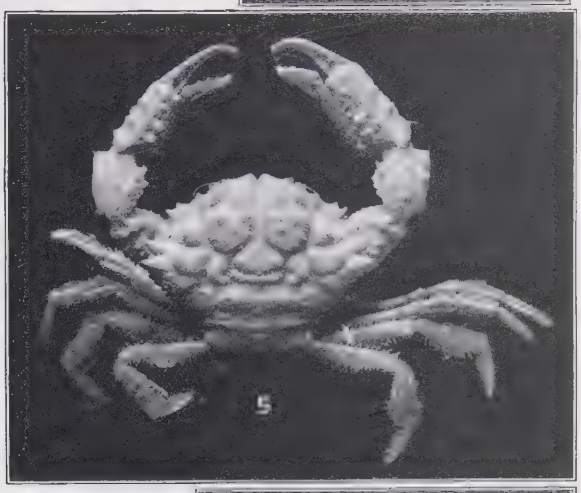
1. *Grapsus strigosus longitarsis*, female, Napili.
2. *Lophozozymus dodone*. Type (female) of *Cancer dodone* Herbst in Berlin Museum.

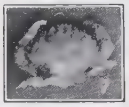
2*a*. *Lophozozymus dodone*. Type (male) of *Cancer dodone* Herbst in Berlin Museum.

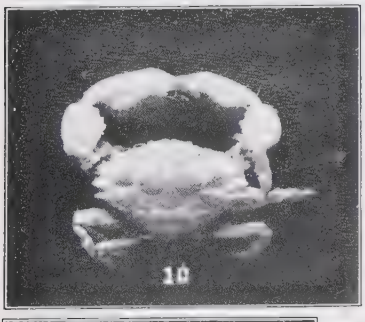
3. *Carpilodes virgatus*, male, type.
4. *Carpilodes coccineus*, male, type.
5. *Carpilodes supernodosus*, male, type.
6. *Xantho lacunosus*, male, type.
7. *Pachygrapsus longipes*, male, Honolulu.
8. *Lophozozymus intonsus*, male, Kailua.
9. *Leptodius waialuanus*, female, type.
10. *Xanthodius bilunguis*, female, type.

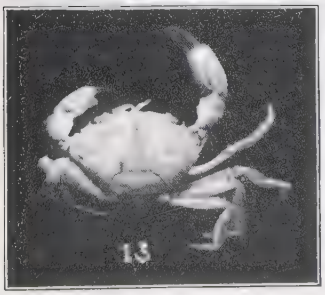


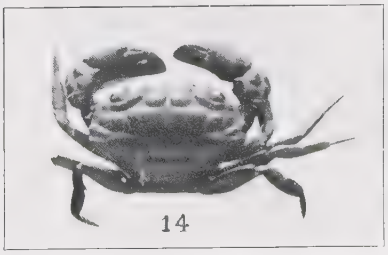






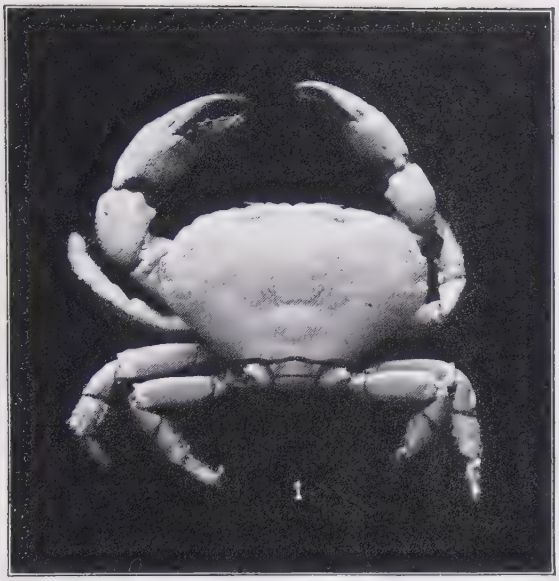


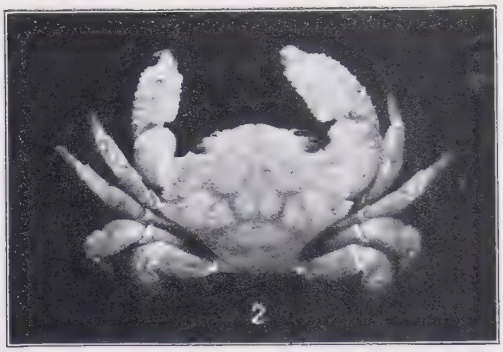


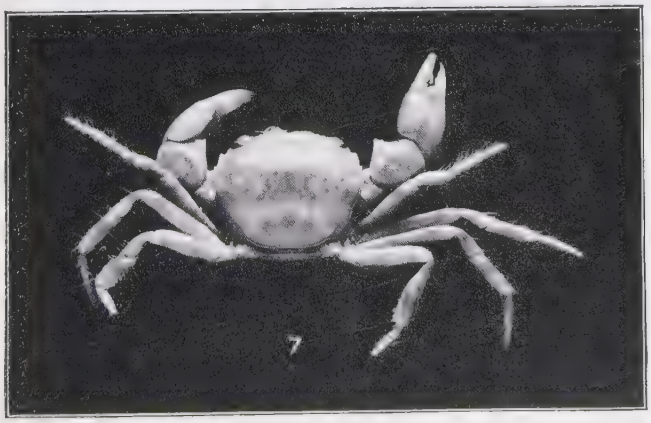


1. *Leptodius molokaiensis*, male, type.
2. *Leptodius gracilis*, male, Hawaiian Islands
3. *Leptodius nudipes*, male, Hawaiian Islands.
4. *Actæa nodulosa*, male, station 4032
5. *Medæus ornatus*, male, station 3872.
6. *Cycloxanthops angustus*, female, type.
7. *Etisodes electra*. Type (male) of *Cancer metis* Herbst in Berlin Museum
8. *Actæa garretti*, male, type.
9. *Actæa hawaiiensis*, male, type.
10. *Medæus simplex*, male, Hilo
11. *Xanthias flavescens*, male, type
12. *Xanthias canaliculatus*, female, type
13. *Micropanope sculpta*, female, type
14. *Xanthias minutus*, male, station 4169.
15. *Banareia villosa*, female, type.

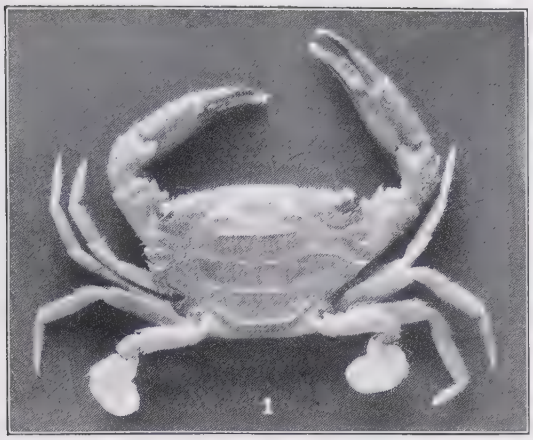
ETISUS SPLENDIDUS, MALE, TYPE.

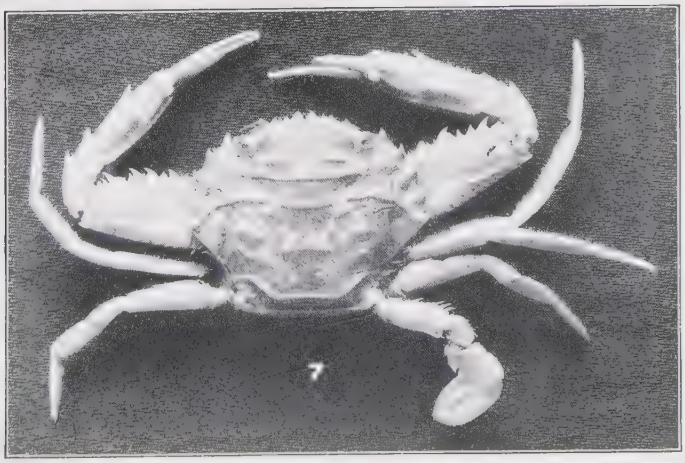




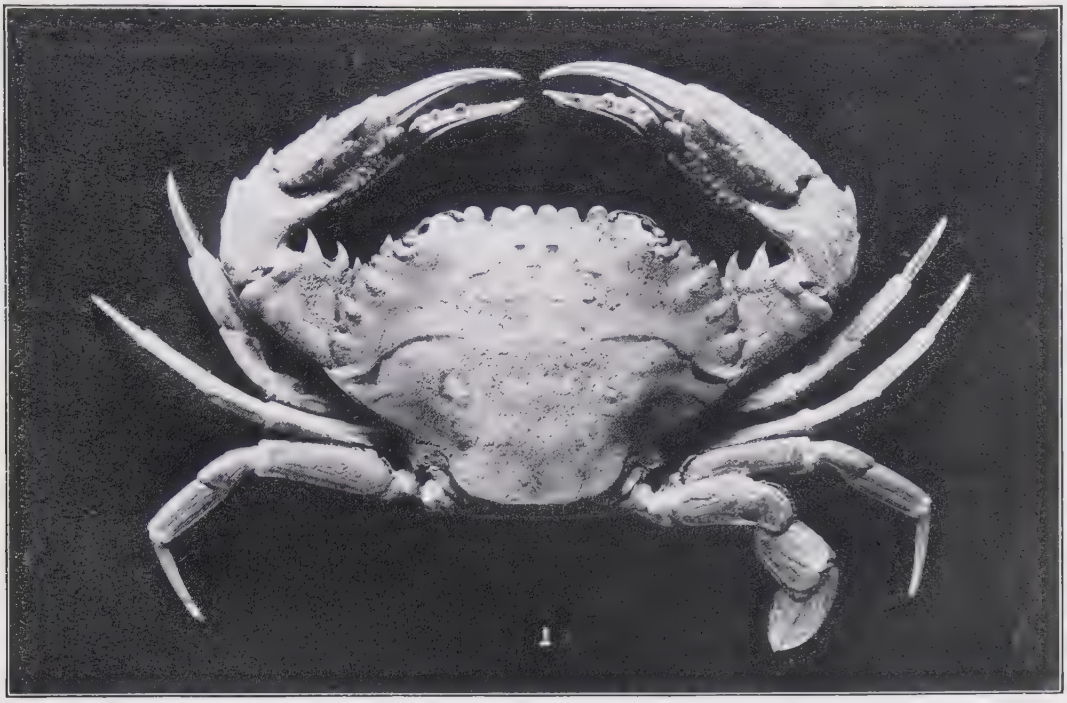


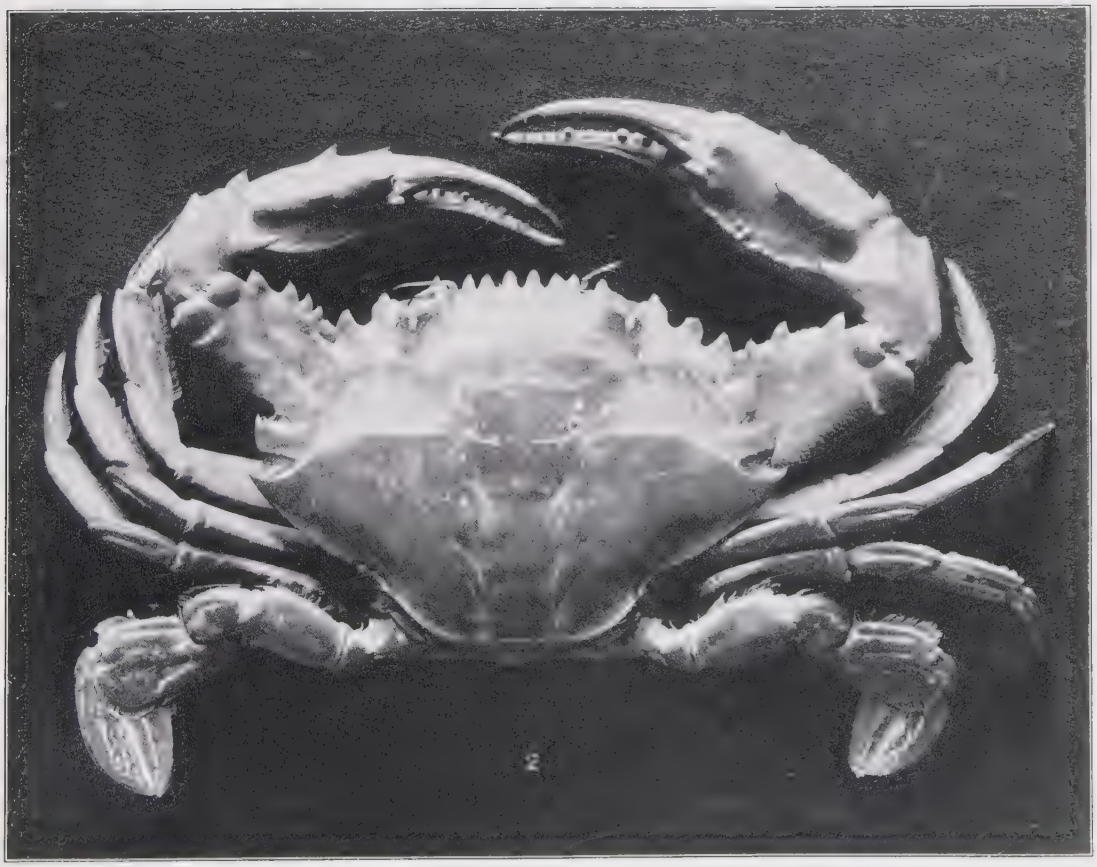
1. *Pseudozius inornatus*, male, Kailua.
2. *Actumnus obesus*, male, station 3849.
3. *Pilumnus taeniola*, female, type.
4. *Menippe convexa*, female, type.
5. *Grapsillus rufopunctatus*. Type of *Cancer rufopunctatus* Herbst in Berlin Museum.
6. *Grapsillus cymodoce*. Type of *Cancer cymodoce* Herbst in Berlin Museum.
7. *Platyozius laevis*, female, station 3876.
8. *Pilumnus nuttingi*, female, type.





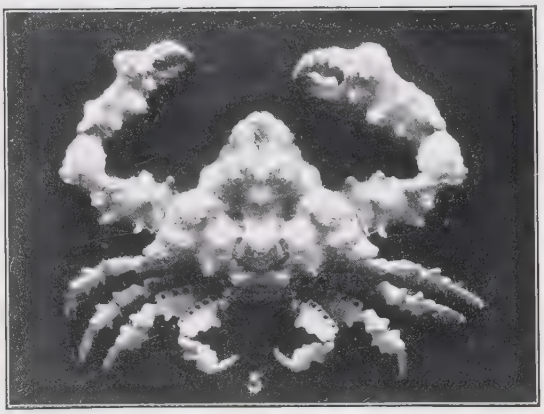
1. *Thalamita anaensis*, male, type.
2. *Portunus* (*Achelous*) *granulatus*, male, station 4159.
3. *Parathranites hexagonum*, male, type.
4. *Portunus* (*Achelous*) *orbicularis*, female, station 3962.
5. *Portunus* (*Xiphonectes*) *macrophthalmus*, male, type.
6. *Portunus* (*Xiphonectes*) *longispinosus*, male, Honolulu Reef
7. *Lupocyclus quinquedentatus*, male, type
8. *Phymodius laysani*, female, type
9. *Goniocaphyra inæqualis*, male, station 3876.

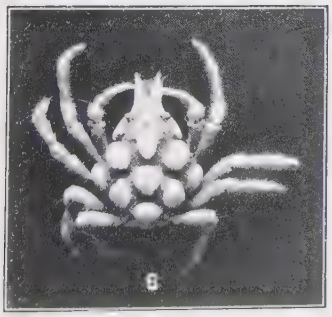


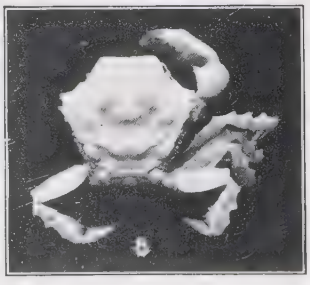


1 *Charybdis orientalis*, male, Honolulu.

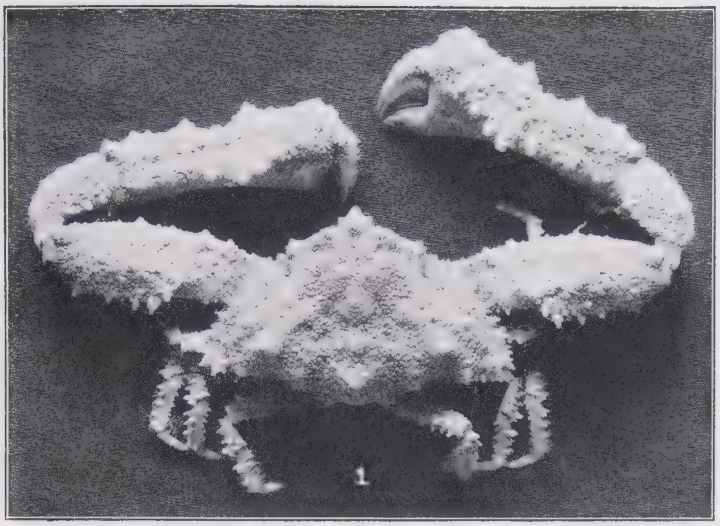
2. *Charybdis japonica*, male, Japan.

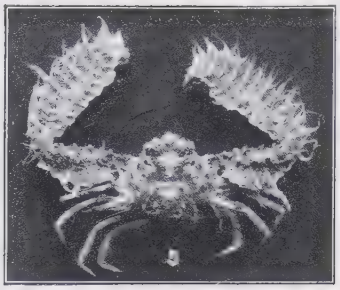


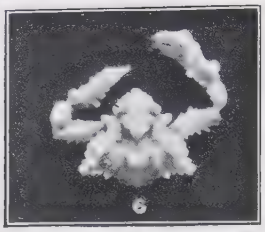


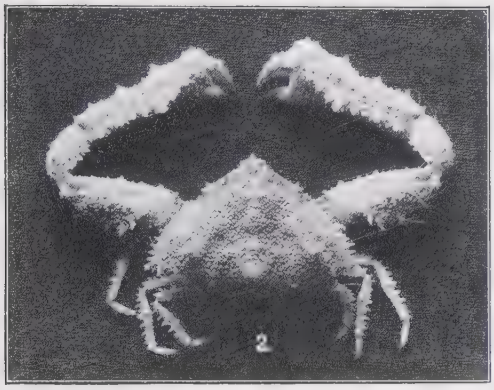


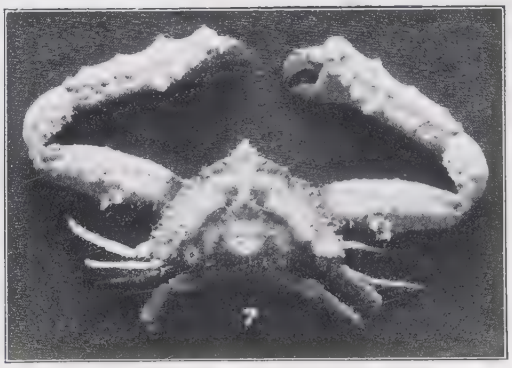
1. *Portunus pubescens*, male, Honolulu market.
2. *Kraussia henderson*i, female, station 3876.
3. *Kraussia integra*, female, station 3955.
4. *Parthenope* (*Platylambrus*) *nummifera*, male, type.
5. *Daldorfia horrida*, male, station 3874.
6. *Sphenocarcinus carbunculus*, female, type.
7. *Chlorinoides goldsborough*i, male, type.
8. *Harrovia truncata*, male, type.

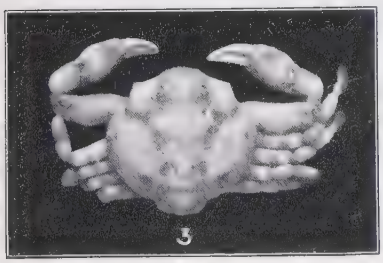


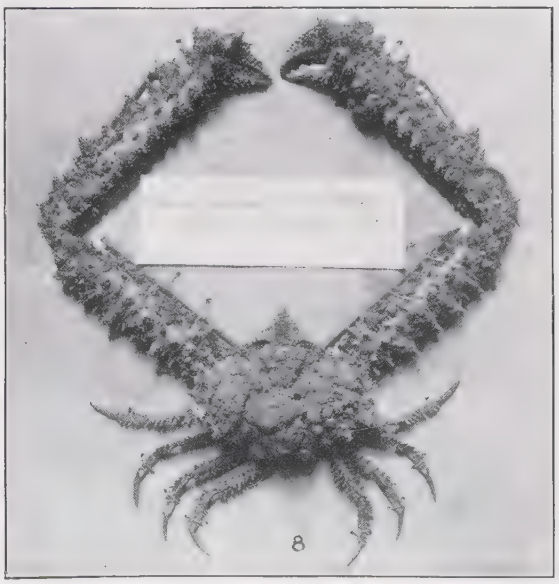




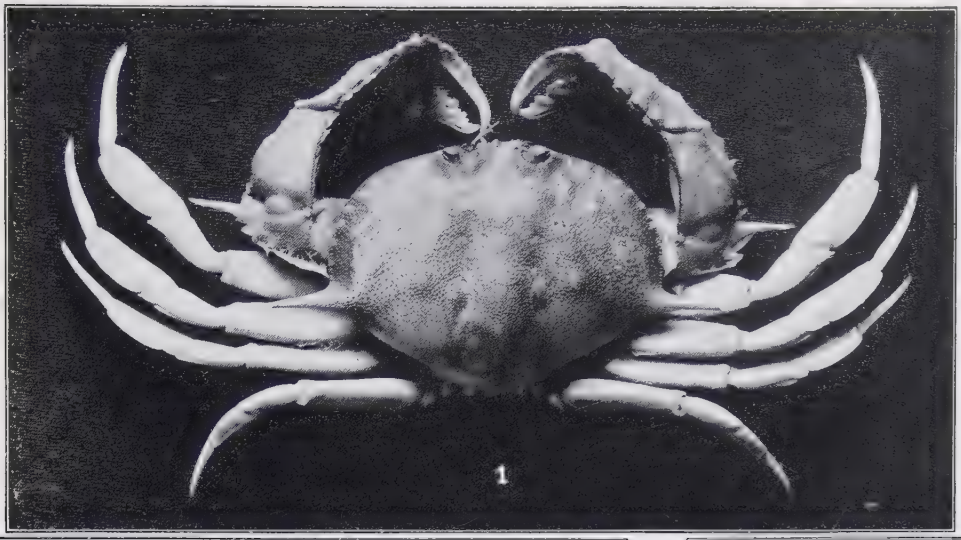


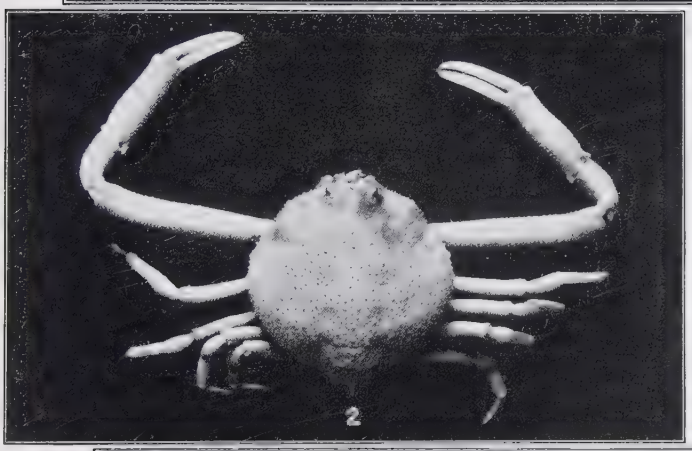


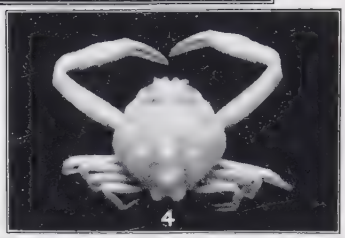


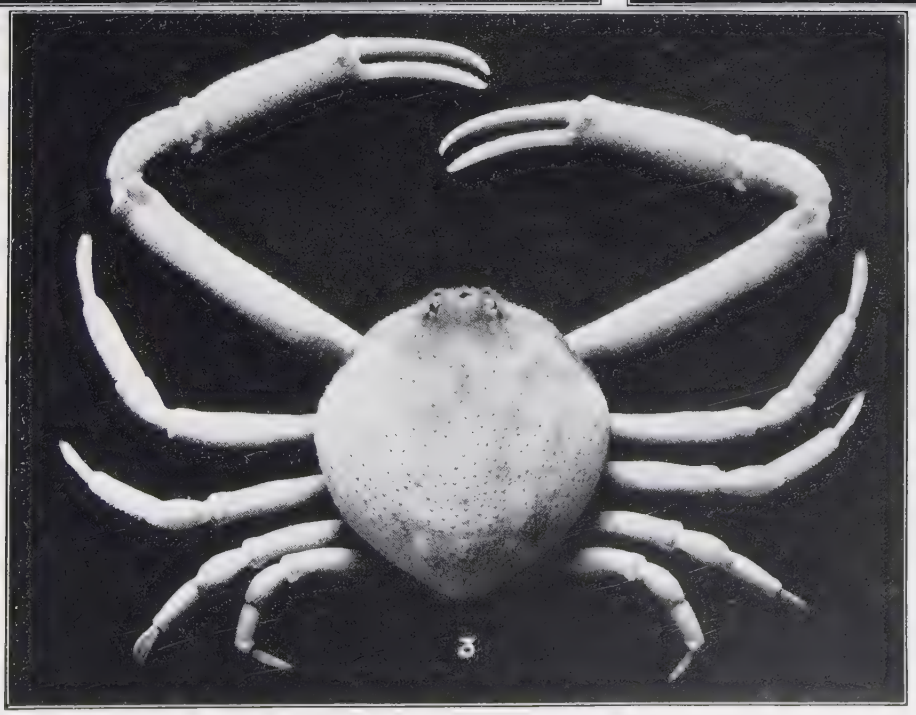


1. *Parthenope* (*Platylambrus*) *stellata*, male, type.
2. *Parthenope* (*Platylambrus*) *stellata*, sharp-spined variety, male, station 4045.
3. *Ebalia jordani*, male, type.
4. *Ethusa mascarone hawaiiensis*, female, type.
5. *Parthenope* (*Aulacolambrus*) *whitei*, male, station 3847.
6. *Parthenope* (*Parthenolambrus*) *calappoides*, male, station 4164.
7. *Parthenope* (*Platylambrus*) *stellata lacunosa*, male, type.
8. *Parthenope* (*Platylambrus*) *echinata* (Herbst). Type of *Parthenope giraffa* Fabricius, in Kiel Museum.

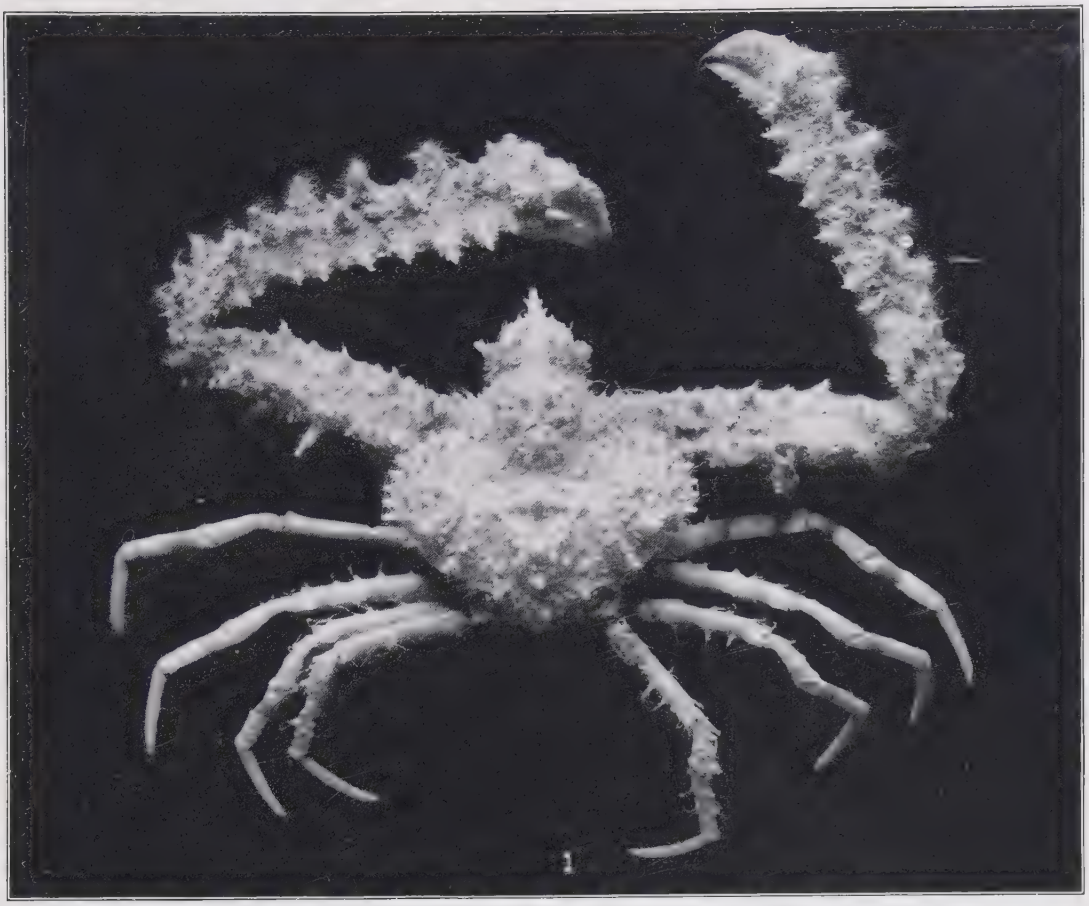


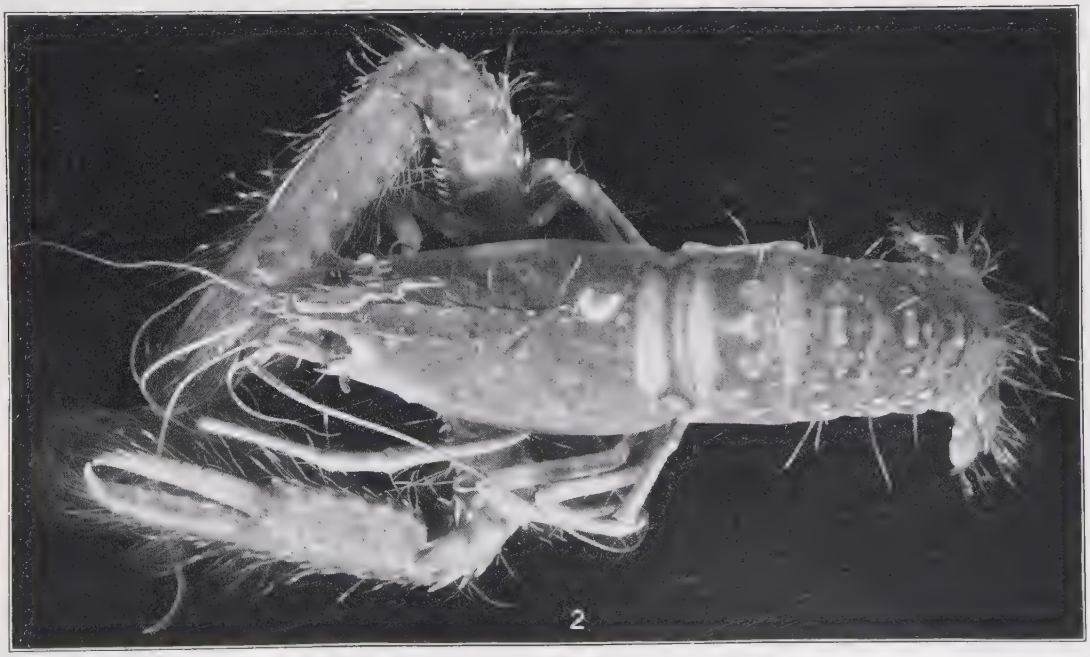






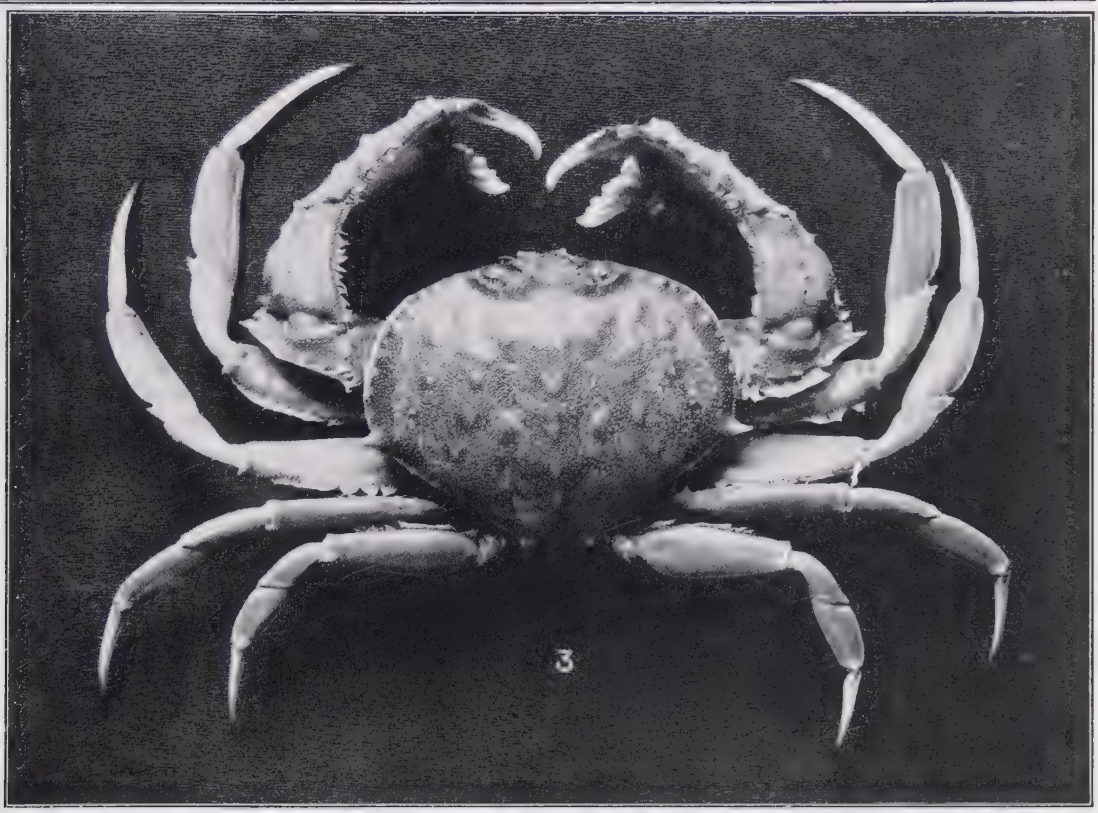
1. *Mursia spinimanus*, male, type.
2. *Randallia distincta*, half-grown male, station 4117.
3. *Randallia distincta*, full-grown male, station 4044.
4. *Randallia gilberti*, male, station 4062.
5. *Tlos angulatus*, female, type.



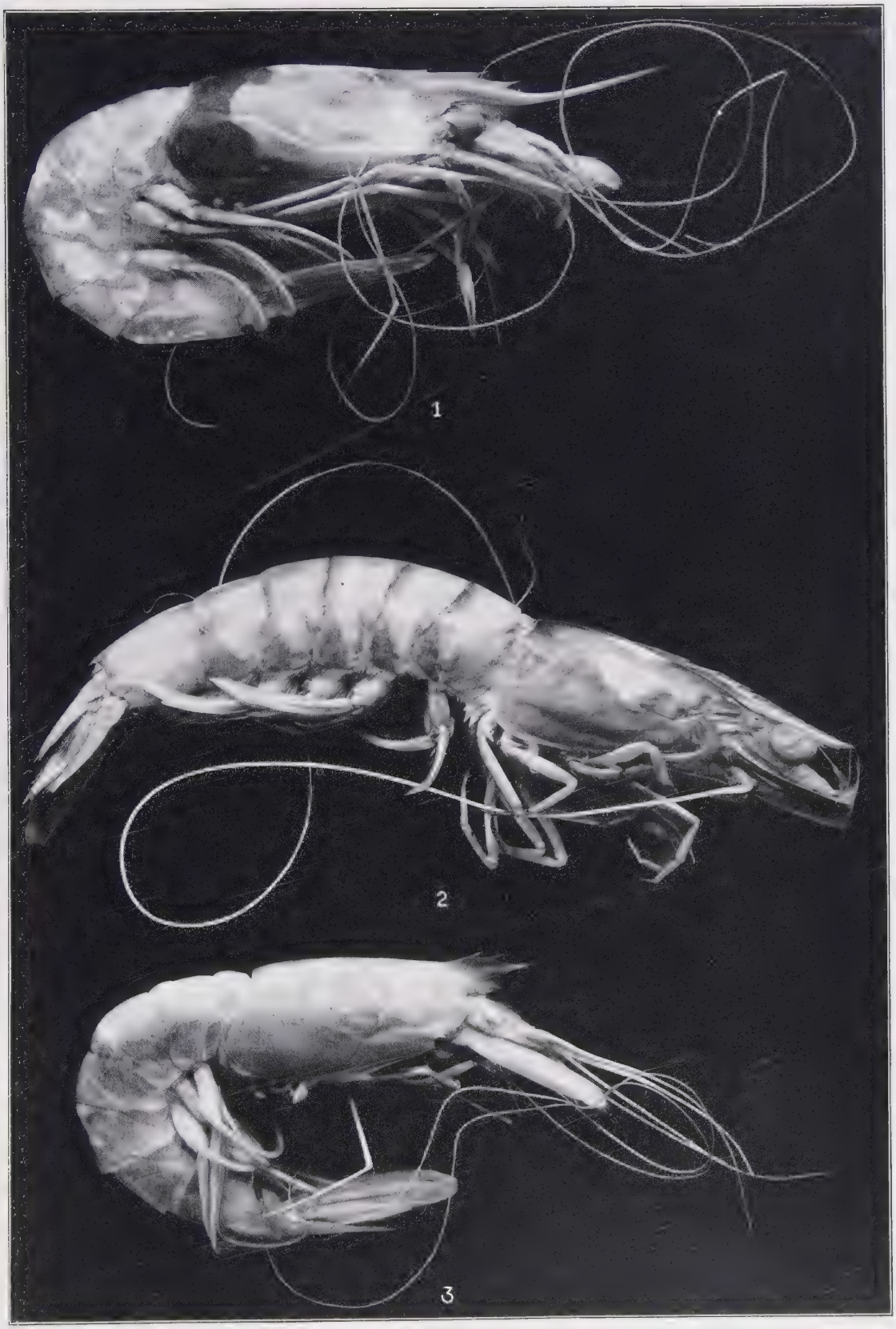


1. *Parthenope* (*Rhinolambrus*) *lamelligera*, male, station 4164.

2. *Enoplometopus occidentalis*, male, Honolulu market.

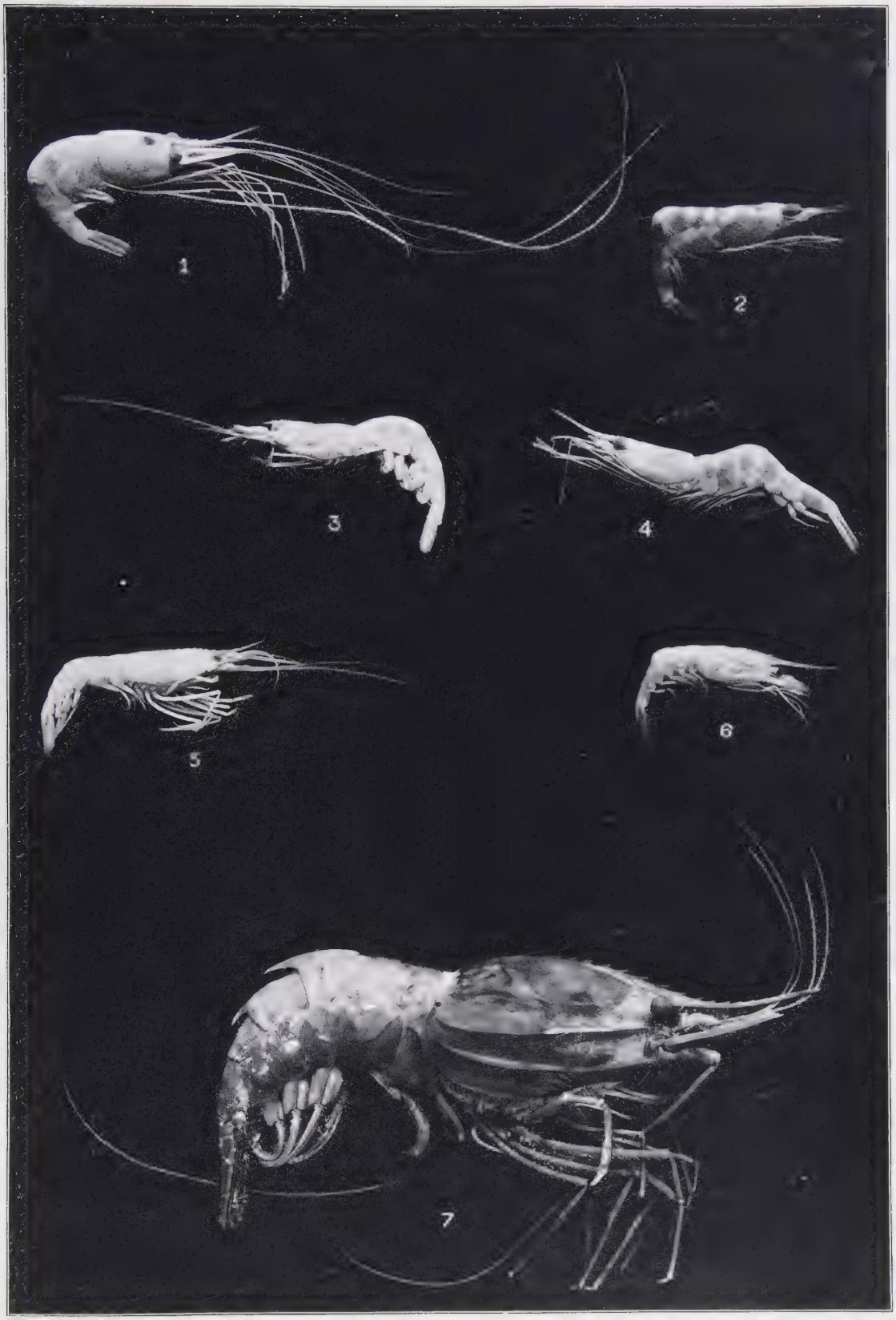


1. *Sergestes robustus*, spined variety, station 4041.
2. *Scyllarus martensi*, female, station 3872.
3. *Marsia hawaiiensis*, male, station 4080, dorsal view.
4. *Marsia hawaiiensis*, male, station 4080, ventral view.
5. *Parribacus papyraceus*, male, type

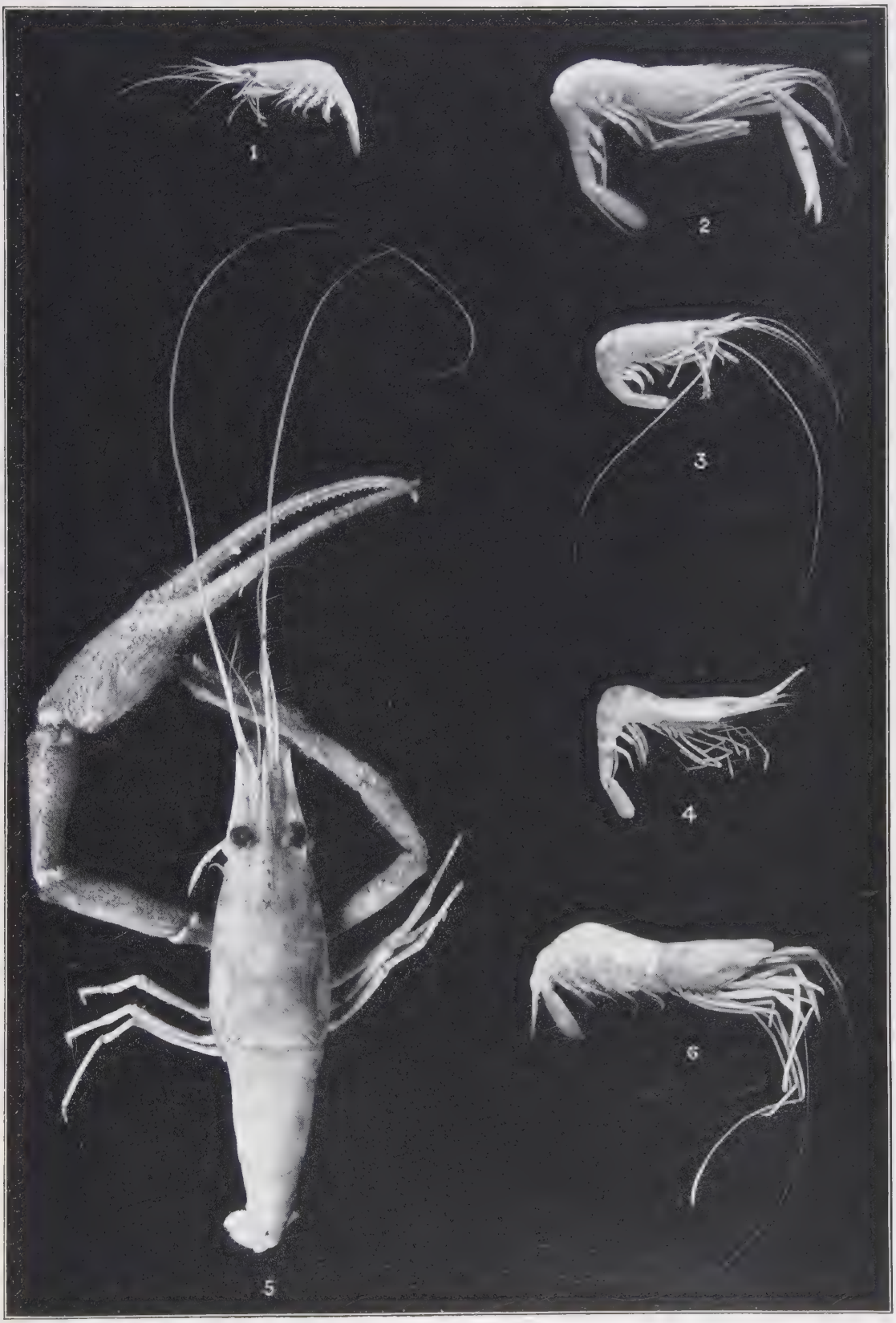


1. *Aristeus semidentatus*, female, station 4016. 2. *Penæus marginatus*, female, station 4070.
3. *Benthesicymus laciniatus*, female, type.

1. *Metapenæus evermanni*, female, type.
2. *Metapenæus richtersii*, female, station 3812.
3. *Metapenæus mogiensis*, female, station 3851.
4. *Haliporus modestus*, female, station 4102.
5. *Metapenæus velutinus*, female, station 3853.
6. *Sicyonia longicauda*, female, station 3865.
7. *Sicyonia lævis*, female, station 3859.
8. *Oplophorus foliaceus*, female, type.
9. *Solenocera lucasii*, male, station 3987.



1. *Pandalus ocellus*, station 3858.
2. *Pandalus exiguus*, female, type.
3. *Pandalus brevis*, male, type.
4. *Pandalus sindoi*, type.
5. *Pandalus spinidorsalis*, station 3986.
6. *Heterocarpus signatus*, type.
7. *Heterocarpus ensifer*, station 3472.



1. *Palæmon debilis*, female, Kealakekua Bay.
2. *Palæmonella laccadivensis*, station 3989.
3. *Palæmon paucifcus*, Hilo.
4. *Palæmon pandaloides*, type.
5. *Bithynis grandimanus*, male, Honolulu market.
6. *Processa processa*, station 3874

1. *Stylodactylus discissipes*, female, station 4002.
2. *Pasiphæa flagellata*, type.
3. *Egeon orientalis*, female, station 4166.
4. *Pasiphæa kaiwiensis*, female, station 3470.
5. *Pasiphæa truncata*, type.
6. *Nematocarcinus tenuirostris*, station 4015.

1. *Coralliocaris quadridentata*, type.
2. *Coralliocaris truncata*, type.
3. *Hippolyte acuta*, Honolulu Reef.
4. *Hippolysmata paucidens*, female, type.
5. *Spirontocaris kauaiensis*, type.
6. *Hippolysmata acicula*, type.
7. *Periclimenes pusillus*, station 3921.
8. *Spongicola henshawi*, female, type.
9. *Polycheles snyderi*, male, type.
10. *Spirontocaris profunda*, female, type.
11. *Polycheles asper*, female, type.
12. *Harpilius depressus*, female, Honolulu Reef.

HYDROIDS OF THE HAWAIIAN ISLANDS COLLECTED BY THE STEAMER ALBATROSS IN 1902.

By C. C. NUTTING,
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Previous to the Hawaiian cruise of the *Albatross* almost nothing was known regarding the hydroid fauna of that region. So far as the writer has been able to ascertain, but three species had been reported from those waters—two having been collected by the *Challenger* and one having been mentioned by Hartlaub as collected by Professor Schauinsland from near the island of Laysan.

The collection forming the basis of this report is thus from practically virgin territory, and when it is remembered that the Hawaiian Islands are farther removed from any continental mass than any other group of similar size, it will be seen that forms of unusual interest would probably be found which would throw light on the morphological and geographical relationships of the Hydroida as a whole. With these considerations in view it will be readily understood that the study of this collection was undertaken with keen interest. The result, however, has been far beyond any reasonable anticipation. It is doubtful whether any other collection, approximately of the same size, made during the last quarter of a century has yielded so great a number of unusually interesting forms.

Of the 49 species collected 29 are new, and as a whole these latter are more certainly distinct from previously known forms than is usually the case. As might have been expected, the majority of the novelties were found among the Calyptoblastea, but the most surprising occurred among the Gymnoblastea, a suborder that has comparatively few representatives in tropical waters. Of the 7 species of these latter, 2 were well-known Holarctic forms, 2 were new species of a genus hitherto known only from the Mediterranean, and 2 were so different from anything heretofore known that the writer has been unable to place them in any previously defined family, and has been forced to establish new families of Hydroida for their reception.

Another interesting and unexpected feature of this collection is the unusual proportion of forms provided with fascicled stems, more than half of the entire number of species being thus characterized, and all but one of the gymnoblastic forms. As has elsewhere been shown[a], the accessory tubes of the fascicled stem are in reality modified hydrocladia, and their utility lies in giving additional strength to the stems. Why this particular feature is so often developed in the Hawaiian region it is hard to imagine, especially as by far the greater number of species were taken in depths presumably beyond the influence of pronounced wave action.

[a] Nutting, American Hydroids, Part II, p. 5, 1904.

A study of the geographical distribution of the forms included in the collection reveals unmistakable relationship with the Australian region. One indication pointing strongly to this conclusion is the great number of Plumularidæ, which constitute about one-third of the species. The west coast of North America, and particularly Alaska, is characterized by a relatively poor representation of that interesting family, while Australia is one of the great centers of distribution of these typically tropical hydroids, the only region that rivals it being our own West Indian waters. In proportion to the total number of species collected, the Hawaiian region seems to be nearly as rich in these very graceful and interesting Hydroida as is the Australian.

In the following table the author has included, for the sake of completeness, the two Hawaiian forms, *Campanularia retroflexa* Allman and *Plumularia buskii* Bale, that were not collected by the *Albatross* during her recent cruise.

Geographical and bathymetric distribution of Hawaiian Hydroids.

(The asterisks denote the new species in the Albatross collection.)

	Australia.	California.	West Indies.	Alaska.	Arctic.	European.	New England coast.	Bathymetric distribution, in fathoms.
*Hydrodendrium gorgonides								272–296
Ceratella fusca	+							
Eudendrium rameum	+	+			+	+		99
Eudendrium capillare					+	+	+	134
*Balea mirabilis								127
*Corydendrium corrugatum								99 314
*Corydendrium minor								99 138
*Halecium scandens								59
*Campanularia eloisa								59–138
Campanularia spinulosa								52
Campanularia retroflexa[a]								20–40
*Stegopoma gilberti								122–143
*Stegopoma gracilis								95–213
*Stegopoma plumicola								59–163
*Opercularella longicauda								138
Calycella syringa		+		+		+	+	95
Lafoëa dumosa	+	+		+	+	+	+	10–143
Lafoëa fruticosa		+		+	+	+	+	99 176
*Lafoëa contorta								59–122
Lictorella halecioides	+				+	+	+	95–163
*Lictorella cervicornis								138
Filellum serpens		+			+	+	+	?
Cryptolaria pulchella								14–506
*Cryptolaria symmetrica								13–225
*Cryptolaria operculata								138
*Sertularia snyderi								59–163
Sertularella lata	+							44–134
Sertularella dentifera		+						129–293
*Sertularella torreyi								40–406
*Sertularella crenulata								95
Pasythea quadridentata	+		+					Surface.
Thuiaria fenestrata	+							14–20
*Diphasia palmata								134
Synthecium tubithecum			+					70–75
Synthecium orthogonia								14
Plumularia corrugata								122
*Plumularia jordani								73–130
Plumularia buskii	+							?
*Plumularia delicata								56–495
*Plumularia milleri								95
Monostæchas quadridens			+					122–138
*Monostæchas fisheri								56–59
*Antennella complexa								30–134
? Aglaophenia rigida			+					52
*Thecocarpus niger								16–163
Lytocarpus phœniceus	+							52–387
*Lytocarpus hawaiensis								44–115
*Lytocarpus balei								47–155
*Lytocarpus similis								213
*Halicornaria flava								59–163
*Halicornaria bryani								213

[a] This species and also *Plumularia buskii* were not in the collections secured by the Albatross. They are included here in order to make the record of distribution as complete as possible, being the only known Hawaiian species that were not secured by the Albatross.

An analysis of the foregoing table shows that of the 51 species included 31 are peculiar to the Hawaiian region, leaving 20 that are found elsewhere. Of these latter 7 may be regarded as Holarctic, all being found in the arctic region and on the coasts of northern Europe, as well as in the North Pacific; these are *Eudendrium rameum*, *Eudendrium capillare*, *Calycella syringa*, *Filellum serpens*, *Lafoëa dumosa*, *Lafoëa fruticosa* and *Lictorella halecioides*. All but one of these (*Eudendrium rameum*) have been found on our New England coast and 4 of them have been reported from Alaska.

Excluding these Holarctic forms and *Pasythea quadridentata*, found in temperate and tropical seas throughout the world, there are 12 species still to be discussed. Seven of these—namely, *Ceratella fusca*, *Campanularia spinulosa*, *Sertularella lata*, *Thuiaria fenestrata*, *Synthecium orthogonia*, *Plumularia buskii*, and *Lytocarpus phœniceus*—are, with a single exception[a], known to occur only in the Australian region. Of the remaining 5 species 2, *Sertularia dentifera* and *Plumularia corrugata*, have hitherto been reported from the California coast only; and 3, *Synthecium tubithecum*, *Monostæchas quadridens*, and *Aglaophenia rigida*, are West Indian, although the last of these is identified with much doubt.

Recapitulating, the distribution of the known Hawaiian species of hydroids may be summed up as follows:

Species peculiar to the Hawaiian region	31
Holarctic species	7
Pelagic and widely distributed	1
Australian species	7
Californian species	2
West Indian species	3

As would be expected from the isolated position of the Hawaiian Islands, the preponderance of peculiar species is very exceptionally large. At first sight it would appear that the Holarctic and Australian relationships were equal. A little consideration, however, will show us that the relationship with Australia is decidedly more intimate than that with the more northern great faunal area. This is strikingly shown, as has already been intimated, by the large number of plumularians included in the collection, embracing about one-third of the entire series. The occurrence of *Ceratella fusca*, a representative of an essentially Australian family, is also significant.

In connection with the appearance of three West Indian forms in the Hawaiian Islands it is interesting to remember that Dr. Alexander Agassiz, in discussing the echinid fauna of the West Indies, says:

> The resemblance of the fauna of the Gulf of Mexico and the Caribbean to that of the Pacific was noticed by writers, even at a time when the materials available for comparison included but little beyond the littoral fauna. * * * In fact, the deep-sea fauna of the Caribbean and of the Gulf of Mexico is far more closely related to that of the Pacific than to that of the Atlantic. Before the Cretaceous period the Gulf of Mexico and the Caribbean were undoubtedly in freer communication with the Pacific than with the Atlantic Ocean.[b]

It is somewhat strange that the large and cosmopolitan genus *Sertularia* has but one representative in the collection. This seems all the more remarkable when we

[a] *Sertularella lata* was secured by the *Challenger* on the Brazilian coast.
[b] Three Cruises of the *Blake*, vol. 1, p. 157, 1888.

remember that there are 32 species of that genus in Australian waters, as shown by Bale in his Catalogue of Australian Hydroids.

Hydroids were secured at 37 stations during the Hawaiian cruise, and at depths ranging from 10 to 500 fathoms. At 20 of these stations the depth was over 100 fathoms. The bottom was exceedingly rough almost everywhere, making successful dredging unusually difficult. The region is undoubtedly one favorable to hydroid life, and the depth at which the dredging was done was within a range which furnishes suitable conditions for both shallow and deep water forms. Notable hauls were made at the following stations:

Station 3854, off south coast of Molokai Island, 134 fathoms; 8 species.

Station 3859, between Molokai and Maui islands, 138 fathoms; 9 species.

Station 3939, off Laysan Island, 163 fathoms; 6 species.

Station 4098, off north coast of Maui Island, 95 fathoms; 6 species.

Station 4802, between Maui and Molokai islands, 122 fathoms; 6 species.

It is worthy of note that all of these hauls are in depths of from 95 to 163 fathoms.

SYSTEMATIC DISCUSSION.

HYDRODENDRIDÆ, new family.

Trophosome.—Colony branching, the hydrocaulus being composed of a spongy mass of chitinous tissue, which is covered with an external coating of naked cœnosarc. Hydranths with a single whorl of filiform tentacles and a flat hypostome, resembling the oral disc of an actinarian.

Gonosome.—Sexual products borne in large hernia-like protuberances from the hydranth bodies. No sign of medusoid structure or of a blastostyle. Colonies bisexual.

HYDRODENDRIUM Nutting, new genus.

There being but a single known representative of the family, the generic definition can not at present be constructed, but will have to be essentially that of the family.

Hydrodendrium gorgonoides Nutting, new species.

(Pl. I, figs. 1–6; pl. VII, figs. 1, 2.)

Trophosome.—Colony flabellate in form and attaining a height of a foot or more, judging from the much-broken pieces secured. Hydrocaulus very woody and thick, the main stem in some places being as much as ¾ of an inch in thickness. The superficial fibers of which the hydrocaulus is composed are in general parallel, and ascend in a twisted or spiral manner. Branches very irregular and dendritic, the ultimate branchlets sometimes anastomosing to a limited extent. Hydranths irregularly scattered over the stem and branches, but showing a tendency to aggregate in the angles between adjacent branches and in the protected portions of the meshwork formed by the anastomoses of the terminal branchlets. Hydranths with a cylindrical body, which is rather short and stout in preserved specimens, an oral surface resembling the oral disc of simple actinians, and a single whorl of filiform tentacles around the margin of the disc, the tentacles having a somewhat nodulated appearance, owing to the presence of nematocyst batteries. The individual hydranths arise, not from a single cœnosarcal tube, but from several distinct filaments from the free cœnosarc with which the hydrocaulus is covered. (See figure 1.)

Gonosome.—The gonophores, if it is proper to call them such, are in the form of immense hernia-like protuberances from the middle or lower portion of the body of the hydranths, there being but one to a hydranth. Although the hydranths bearing these bodies are usually apparently unmodified, they sometimes appear to be somewhat shrunken, as if impoverished by the growth of the gonophores. These latter show no trace of medusoid structure, either externally or in sections, and, what is more remarkable, there is no sign of anything like a blastostyle or spadix. Gonophores bearing ova, and others bearing spermatozoa, are found on the same colony.

Distribution.—Station 3991, between Honolulu and Kauai Island, 296 fathoms.

This species being a representative of a new family, it seemed advisable to investigate it somewhat in detail, especially regarding certain histological features, some of which are worthy of further mention.

The stem.—Although presenting every appearance of being polysiphonic, this structure is not homologous with the ordinary polysiphonic stem. A cross section reveals the fact that we have here to deal not with a series of parallel tubes, but with a series of irregular lacunæ greatly lengthened along the axis of the stem and inclosed in a common matrix, as it were, of chitin. In cross section these lacunæ are of various sizes and shapes, and on the surface they reveal themselves as cross sections of deep irregular grooves, rather than tubes. (See fig. 4.)

Toward the interior of the section the cœnosarc appears often to be wanting in these spaces, but toward the surface the lacunæ are filled with it. The superficial grooves are filled, and here the cœnosarc overflows, as it were, and forms a complete investment of the stem. It will thus be seen that the cœnosarc is much deeper over the superficial grooves than between them, where the superficial layer is very scant. Being thus molded into the grooves the cœnosarc here forms thickened strands, several of which unite to form the hydranth body.

From an examination of such a section as is shown in figure 4 it seems that the mode of growth of the stem is somewhat as follows: Reasoning from homology, it is altogether probable that the chitinous parts of the hydrocaulus are formed by the ectoderm, although I have been unable to work out the beginning of this process. The deposition of chitin, then, takes place at the periphery of the lacunæ, the latter thus becoming smaller as the chitin invades them, in some cases, doubtless, being almost obliterated. Near the surface the ridges appear to be built up more rapidly than the bottoms of the grooves, and the outer or superficial sides of the grooves thus tend to meet or be bridged over with the rapidly forming chitin. Thus the spaces which were originally cross sections of deep grooves finally become round in section and appear to be sections of tubes, and we have, as a result, a stem, which, although morphologically polysiphonic or fascicled, is not so in strict homology, on account of the great difference in the manner of its formation.

Unless one has studied the formation of the skeletons in other cœlenterates, such as corals and Hydrocorallinæ, it is difficult to understand the mutual relations of endoderm, ectoderm, and chitin in this new form. Without entering into further discussion, however, it will suffice to say that the relations here and in the Hydrocorallinæ are, in my opinion, strictly homologous.

The Hydranths.—Cross sections and longitudinal sections of the nutritive "persons" of the colony show that they are typical hydroids, although they bear a distinct superficial resemblance to actinoid polyps. They are made up of the ordinary histological layers, the body cavity being simple and showing no trace of œsophageal tube or mesenterial filaments. There is practically no proboscis, the mouth being in the center of a flat oral disc, as in the actinians. At its base the hydranth body, or rather its foot, becomes continuous with the strands of cœnosarc which fill several of the adjacent superficial grooves of the hydrocaulus, and it is altogether probable that the lumen of the body is directly continuous with the central cavities of these tubes, although the condition of the material did not allow of definitely proving this point. The tentacles are solid, noncapitate, and arranged in a single circlet around the edge of the oral disc.

Gonosome.—This is the most remarkable feature of the form under consideration, being, in my opinion, the most primitive known among the Hydroida. Upon the body of an unmodified hydranth, below its middle, is borne a huge, hernia-like protuberance that is sometimes almost as large as the hydranth from which it springs. But a single one of these is borne on a single hydranth. Upon sectioning this strange gonophore it is found to be a simple sack, opening widely into the body cavity of the hydranth and consisting simply of the ordinary layers of the hydranth body, endoderm, ectoderm, and supporting layer, or "Stutzlamelle."

The male and female gonophores are borne on the same colony and are externally quite similar in appearance. Internally, they differ only in the sexual elements inclosed. If the gonophore is female, the developing ova are seen to be embedded in the endoderm, the older ones being distal and the younger being proximal in position. There is not a trace of any medusoid structure to be seen, carefully prepared sections, both transverse and longitudinal, showing no sign of radial canals or of blastostyle or manubrium. In the section figured in figure 5, plate 1, the line of ova can be traced around the bend where the gonophore joins the hydranth body until the smaller ones are seen embedded in the endoderm of the body wall itself. It seems likely, therefore, that they are originally differentiated in the endoderm of the body wall and afterwards are carried along with the portion of the wall that is pushed outward to form the hernia-like gonophore. Or they may migrate outward

after the gonophore is partially formed, as Weismann and others have found to be the case in many hydroids. The male gonophore, as said before, differs from the female only in bearing spermatozoa instead of ova. (See fig. 6, pl. I.)

In *Hydra* the ova are formed directly in the body wall of functional hydranths, and there is nothing that can be called a true blastostyle as distinct from the hydranth itself. Here, however, each ovum is inclosed in a separate closed sack, develops a hard encasing wall around itself, and later develops a statoblast.

It thus appears that the reproductive parts in the *Hydra* are in some respects more highly specialized than those found in *Hydrodendrium*.

Relationships of the family Hydrodendridæ.—Up to comparatively recent times there was but one known family of Hydroids that exhibited the peculiar character of having the skeleton composed of a chitinous network which was covered with a layer of cœnosarc, and that was the family Hydractinidæ. Prof. Louis Agassiz, with his usual clear insight, recognized the relationship between this family and the Milliporidæ, the details of which have been worked out by several writers, including Professor Moseley. Since that time two other families having this characteristic have been described. One of these, the Ceratellidæ[a], was instituted in 1868 by Doctor Gray, who regarded it as a family of sponges. In 1888 Bale recognized its family rank and also that it was composed of true hydroids. In 1891 Prof. W. Baldwin Spencer, of Melbourne, discovered another remarkable form, *Clathrozoon wilsoni*, for which he instituted a new family, the Hydroceratinidæ, in which the colony is branching, as in the Ceratellidæ, but the superficial cœnosarc is enveloped externally by a very thin chitinous layer that incloses the entire hydrocaulus.

It thus appears that up to the present time no less than four families of Hydroida have been described having the common character mentioned above. The collection secured during the Hawaiian cruise of the *Albatross* contains two other species which, in my opinion, should form the types of two additional families of this group, making six in all, which may be characterized briefly as follows:

Table showing the main points of resemblance and difference between the families of Hydroida having the common character of stems composed of a chitinous (in one case calcareous) framework overlaid with naked cœnosarc.

	General character of colony.	Origin of hydranths.	Form of hydranths.	Defensive "persons."	Gonosome.
HYDRACTINIDÆ	An encrusting mass. Spines present. No hydrophores.	From several cœnosarcal tubes.	One circlet of filiform tentacles. Proboscis present.	Spiral zooids.	Borne on modified hydranths. Manubrium present.
CERATELLIDÆ	Branching. No spines. Hydrophores composed of basket-like open-work.	From several cœnosarcal tubes.	Scattered capitate tentacles. Proboscis present.	None.	Medusoid gonophores springing directly from the hydrocaulus.
HYDRODENDRIDÆ	Branching. Neither spines nor hydrophores.	From several cœnosarcal tubes.	One circlet of filiform tentacles. No proboscis.	None.	Gonophores in form of hernia-like open sacks on body of unmodified hydranth.
TUBIDENDRIDÆ (A new family to be described later.)	Branching. Pseudo-hydrophores hardly evident.	From a single cœnosarcal tube.	Two circlets of filiform tentacles. Proboscis present.	Finger-like naked processes. Apparently no nematocysts.	Unknown.
HYDROCERATINIDÆ.	Branching. Tubular hydrophores present. Entire hydrocaulus covered with thin chitinous membrane.	From several cœnosarcal tubes.	One circlet of filiform tentacles. Proboscis present.	Nematophores with evident sarcostyles.	Unknown.
MILLEPORIDÆ	Massive or branching. Skeleton calcareous.	From several cœnosarcal tubes.	One circlet of capitate tentacles. A low proboscis.	Dactylozooids with scattered capitate tentacles.	Medusoid gonophores in ampullæ.

[a] The original spelling Ceratelladæ is here changed to conform to the A. O. U. code and to the practice of nearly all zoologists.

Family CERATELLIDÆ.

Trophosome.—Colony branched. Skeleton in the form of a chitinous network with slight bracket-like or tubular hydrophores serving as a support for the bases of the hydranths. Hydrocaulus in the form of network of anastomosing tubes, the whole inclosed in a common ectoderm layer.

Gonosome.—Gonophores medusoid; fixed and arising directly from the hydrocaulus. This definition is practically the same as that given by Prof. W. Baldwin Spencer in his "On the structure of Ceratella fusca (Gray)." (Transactions of the Royal Society of Victoria, 1891. Reprint, pp. 1–24.)

Genus CERATELLA.

Trophosome.—"Colony irregularly branching; more or less expanded in one plane; growing from a creeping base. Main stem flattened, branches rounded and beset with bracket-like hydrophores."[a]

Ceratella fusca Gray.

But a single specimen of this species was found.

Locality.—Station 4072, north coast of the island of Maui, 56 fathoms.

Ceratella fusca Gray, Proc. Zool. Soc., Vol. VIII, Nov., 1868, 577.

Family EUDENDRIDÆ.

Trophosome.—Colony branched, stem fascicled. Hydranth with a single circlet of filiform tentacles and a trumpet-shaped proboscis.

Gonosome.—The male gonophores form a verticil just beneath the tentacles of the hydranth, each gonophore having 2 to 4 chambers in linear series. Female gonophores not in regular verticils and usually clustered just beneath the tentacles on the bodies of the hydranths. The hydranths in both sexes are often more or less degenerated when bearing gonophores.

Genus EUDENDRIUM.

There being but one genus recognized in the family its characters are as given above.

Eudendrium rameum (Pallas).

Several specimens of *Eudendrium* were secured that I am unable to separate from this well-known form. They show the characteristic dendritic habit of growth of this species, but do not attain the size of British specimens. The gonosome, female, is present and shows no point of differentiation from *E. rameum*.

Localities.—Station 4077, off the coast of the island of Maui, 99 fathoms; station 4135, off the coast of the island of Kauai, 225 fathoms.

This species is of Holarctic distribution, being found off the coasts of Europe, the Arctic region, and in the Pacific as far south as Australia.

Tubularia ramea Pallas, Elenchus Zoophytorum, 83, 1116, 1766.

?**Eudendrium capillare** Alder.

A small specimen without gonosome is very doubtfully referred to this species. The colony is somewhat larger than British specimens.

Locality.—Station 3854, off the south coast of the island of Molokai, 134 fathoms.

?Eudendrium capillare Alder, Catalogue of the Zoophytes of Northumberland and Durham, p. 15, 1857.

[a] Op. cit., p. 20.

TUBIDENDRIDÆ, new family.

Trophosome.—Colony branching, polysiphonic, the hydrocaulus being, at least in part, covered with naked cœnosarc. Ill-defined pseudo-hydrophores are often formed. Hydranths with two well-defined whorls of filiform tentacles, a pyriform body and entirely naked pedicels. Stem beset with irregularly distributed finger-like processes arising from the cœnosarc.

Gonosome.—Not known.

BALEA Nutting, new genus.

The generic characters of the type of this new family can not be defined so long as other members of the family are unknown. The author takes pleasure in naming this remarkable genus after Prof. W. M. Bale, the Australian naturalist, who has done such important work in the Hydroida of the Pacific.

Balea mirabilis Nutting, new species.

(Pl. II, fig. 3; pl. VII, figs. 3, 4.)

Trophosome.—Colony attaining a height of about 5 inches, flabellate in general outline; hydrocaulus polysiphonic, even to the tips of the ultimate branches, and at least partly covered with naked cœnosarc, which occupies parallel open grooves on the surface. Branches irregular, but laterally disposed on the sides of the main stem, sometimes subdividing, and bearing irregularly disposed and often hardly discernible hydrophores that are a mere thin rim around the naked bases of the hydranth pedicels. Hydranths exceedingly irregular in their disposition, apparently most abundant on the distal parts of the colony, where they are sometimes aggregated in clusters; body pyriform, elongated, with a proximal whorl of 12 to 16 filiform tentacles, and a distal whorl of larger filiform tentacles, which are 8 to 12 in number and are inserted on the widest part of the body. The hydranths are borne on rather slender pedicels which are without a covering of chitin. Scattered irregularly over the stem and branches are a number of tentaculiform organs that are unlike anything else known to the writer, although they are likely to prove homologous with sarcostyles. They are apparently almost exactly like the smaller tentacles of the hydranth in general form and structure, as viewed under a fairly high magnification. They are composed of ectoderm and endoderm, but I have thus far failed to find any nematocysts that are clearly defined. In form they have just about the proportion of length to breadth that is seen in the human finger. In life they are probably highly extensible, while in the preserved material they are contracted, in all likelihood, to their least dimensions.

Gonosome.—Unknown.

Locality.—Station 3856, between Molokai and Maui islands, 127 fathoms.

Cross sections of the stem or branches of this remarkable hydroid reveal a relation of tubes different from that found in any other that I have seen. The stem seems to be truly polysiphonic, the section showing a series of tubes much the same as one finds in some of the plumularians. The tubes, however, open quite freely into each other through irregular apertures in their chitinous walls. The walls of the peripheral tubes are much thinner than those of the central ones, and sometimes their outer portions are entirely lacking, thus exposing the naked cœnosarc. While I have not ascertained the manner of growth of this stem with certainty, it seems altogether likely that the cœnosarc pushes through the openings in the walls of tubes already formed and creeps along the grooves between adjacent tubes. At this stage we would have the condition of the cœnosarc on the surface of *Hydractinia*, for instance. Later the cœnosarc begins to form a thin layer of chitin on its outer surface, which arches over the groove and grows thicker and thicker, until finally we have a new tube of chitin with its usual cœnosarcal contents.

Another point of difference between this form and the others described on page 938 lies in the fact that the hydranth arises from a single cœnosarcal tube and not from several. In some cases it arises from one of the central tubes and in others from one of the superficial tubes, which indicates that the latter tubes have been formed after the appearance of the hydranth.

The irregular disposition of the hydranths is another feature that is exceptional, although it is shared with the Hydrodendridæ.

Relationships of the Tubidendridæ.—The form of the hydranth is essentially that of the Tubularidæ, especially as regards the disposition of the tentacles. It differs, however, in the relative size of the

proximal and distal set and in the fact that the pedicel is entirely naked. The character of the stem is unique in that it combines a true fasciculation with the presence of external cœnosarc. The dactylozooids, if such they are, are also unique in the apparent absence of well-defined nematocysts. It is unfortunate that the gonosome is absent, as that would in all probability furnish clews to the true affinities of this strange hydroid.

Family CLAVIDÆ.

Trophosome.—Stem branched or unbranched. Hydranths with scattered filiform tentacles.

Gonosome.—Gonophores either in the form of free medusæ or producing the sexual products in fixed sporosacs.

Allman, in his Monograph of the Gymnoblastic Hydroids, published in 1871, places the genus *Corydendrium* in the family Turridæ, under a mistaken idea that the only species known, *C. parasiticum*, bore medusæ with simple radial canals and simple tentacles. In 1883 Weismann published his Entstehung der Sexualzellen bei den Hydromedusen, in which he points out Allman's mistake and shows that *Corydendrium* produces no medusæ at all (p. 40). Weismann, however, does not attempt any general classification of the hydroids and does not correct the systematic error of Allman.

In 1897 Dr. Karl Camillo Schneider published his "Hydropolypen von Rovigno nebst Uebersicht über das System der Hydropolypen im Allgemeinen," in which he proposes a general revision of the classification of the Hydroida, the result being the throwing of numerous well-established families together and rendering the task of the workers in the Hydroida more perplexing than ever. He places the 20 families of Gymnoblastea recognized by Allman in 4 families. He does not regard *Corydendrium parasiticum* as representing a distinct genus, placing it in the old genus *Clava*.

The present writer thinks that Doctor Schneider is correct in placing this species in the Clavidæ, but that he is in error in failing to recognize the validity of the genus *Corydendrium*.

Genus CORYDENDRIUM.

Trophosome.—Colony branched and fascicled. Hydranths with scattered filiform tentacles.

Gonosome.—Gonophores borne on the stem and branches, in the form of either medusæ or fixed sporosacs.

Corydendrium corrugatum Nutting, new species.

(Pl. II, fig. 2; pl. VII, figs. 5, 6, 7.)

Trophosome.—Colony attaining a height of about 5 inches. Stem and branches fascicled, the former being nearly straight or irregularly but not abruptly bent, and bearing branches that are opposite, subopposite, or alternate, the whole forming a roughly pinnate structure. Branches often showing a well-marked annular constriction near their origins and bearing on their anterior aspect the hydrophore-like structures within which the hydranths retract. These hydrophores are inclined alternately to the right and left, are not very distant, and are cylindrical with a round terminal orifice, an even margin, and are usually distinctly corrugated with deep irregular annulations. Hydranths large, with elongate pyriform body and very numerous filiform tentacles emplanted over the surface so thickly that they almost entirely conceal the hydranth body. Proboscis very dilatable, as shown in figure 7.

Gonosome.—Unknown.

Distribution.—Station 3828, south of the island of Oahu, 319 fathoms; station 4077, northeast coast of the island of Maui, 99 fathoms.

The hydrocaulus of this species is much more thick and rigid than in *C. parasiticum*, and the hydrophores are more distinct and are decidedly corrugated.

Corydendrium minor Nutting, new species.

(Pl. II, fig. 1; pl. VII, figs. 8, 9.)

Trophosome.—Colony growing on a creeping root-stock, parasitic on a species of *Lafoëa*, and attaining a height of about one-half inch. Stem and main branches fascicled, the latter being irregularly disposed and giving forth alternate branches. The ultimate branchlets are not fascicled, but the perisarc is strong and tubular, ending abruptly at base of hydranths. Hydranths with an elongated

pyriform body with about 12 to 16 scattered filiform tentacles, which sometimes show a tendency to form a distal whorl of 4 and a proximal more numerous whorl, the middle part of the body being less thickly beset with tentacles.

Gonosome.—Gonophores taking the form of single medusæ on separate pedicels growing from the branches. The medusæ have 4 radial canals, unbranched, an apparently short, 4-lobed proboscis, and numerous strong marginal tentacles the disposition of which could not be made out in the immature medusæ examined.

Distribution.—Station 3859, between the islands of Molokai and Maui, 138 fathoms; station 4077, northeast coast of Maui, 99 fathoms; station 4098, north coast of Maui, 95 fathoms.

This appears to be a true *Corydendrium*, but it differs from either of the other species of the genus in bearing medusæ. It is much smaller in all its proportions than *C. parasiticum*, with which I have directly compared it.

Family HALECIDÆ.

Trophosome.—Stem fascicled. Saucer-shaped hydrophores borne alternately on branches and often having their margins reduplicated and a circular row of shining spots of dots some distance below the rim. Hydranths with conical proboscis and a single whorl of filiform tentacles.

Gonosome.—Gonophores in the form of either sporosacs or medusæ.

Genus HALECIUM.

Trophosome.—Colony without defensive persons, otherwise as described in the family definition.

Gonosome.—Gonophores in the form of fixed sporosacs. No medusæ.[a]

Halecium scandens Nutting, new species.

(Pl. II, fig. 5; pl. VIII, figs. 1–3.)

Trophosome.—Colony growing like dodder over a specimen of *Lytocarpus phœniceus*, the long stolon-like root-stock running along the main stem of the host for a surprising distance without branching or ramification of any sort. Near the distal end of the host a few branches of *H. scandens* are given off. Stem long, slender, nearly straight, unbranched, divided into very long, slender internodes just above the hydrophores. Hydrophores on short pedicels with broadly flaring margins and without reduplications. Hydranths very large, but the details not distinguishable.

Gonosome.—Gonangia springing from lumen of hydrophores, lenticular, broader than long, with a curious mushroom-like body differing in shape from any others that I have seen, and suggesting the possibility of a medusoid form.

Locality.—Station 3949, north of the island of Laysan, 59 fathoms.

The very great length of the internodes, combined with the shortness of the pedicels and peculiar gonophores springing from the hydrophores, although this latter may be purely sporadic, make this species quite distinct from others of the genus.

Of course if the gonophores produce medusæ the species would go into the genus *Campalecium* Torrey.

Family CAMPANULARIDÆ.

Trophosome.—Hydrothecæ well developed, nonoperculate, either with distinct pedicels or nearly sessile, but not adnate to or partly immersed in the stem or branches. Hydrothecal septum distinct. Hydranth with a trumpet-shaped or subglobular proboscis.

Gonosome.—Gonophores producing either the generative products direct or medusæ which do not bear ova on the proboscis.

The classification of the pediculate Calypteroblastea is at present in an exceedingly unsatisfactory condition, and no two authors are in substantial agreement as to the systematic arrangement of this perplexing group. The present author is by no means prepared to offer a revision at this time, but

[a] Dr. Harry Beal Torrey, in his Hydroida of the Pacific Coast of North America, page 48, describes a new genus of Halecidæ based on his discovery of a form which bears medusæ instead of sporosacs. To this interesting form he has given the name *Campalecium medusiferum*.

has decided to use a classification that will be conservative, not disturbing the more generally accepted arrangements of Hincks and Allman, except where they are manifestly contrary to facts discovered since they were proposed.

Genus CAMPANULARIA.

Trophosome.—Colony usually branched, sometimes fascicled.

Gonosome.—Gonangia producing sexual products which produce planulæ and not medusæ.

Campanularia eloisa Nutting, new species.

(Pl. II, figs. 4, 6; pl. VIII, figs. 4–7.)

Trophosome.—Colony attaining a height of about 5 inches. Stem and main branches fascicled, the pedicels sometimes opposite and sometimes springing from all sides of the main stem and branches, often being directed at right angles to the latter. Hydrothecæ quite large, tubular, with 14 to 16 strong rounded teeth, borne on long slender pedicels which are annulated just below the hydrothecæ, but usually not at the proximal end.

Gonosome.—Gonangia borne on stem and main branches, elongate-ovate in shape, truncate at distal end, proximal portion showing a number of very weak annulations. Pedicels very short. Gonangia considerably shorter than the hydrothecæ.

Distribution.—Station 3853, south coast of Molokai Island, 68.5 fathoms; station 3859, between the islands of Molokai and Maui, 139 fathoms; station 3949, northwest of the island of Laysan, 59 fathoms; station 4077, northeast coast of Hawaii Island, 99 fathoms.

This species evidently belongs to the Verticillata group, having a strongly fascicled stem and scattered pedicels. It differs from *C. verticillata* in the shape of the hydrothecæ and gonangia, and also in the arrangement of the pedicels.

Campanularia spinulosa Bale.

A fragmentary specimen which appears to belong to this species was secured at station 4071, off the north coast of the island of Maui, at a depth of 52 fathoms.

Campanularia spinulosa Bale, Proc. Linn. Soc. New South Wales, III, series 2, 1888, 756.

Family CAMPANULINIDÆ.

Trophosome.—Hydrothecæ pediculate, tubular, with an operculum composed of several converging segments forming a tent-like structure. Hydranth with a conical proboscis.

Gonosome.—Gonangia producing either the sexual elements direct or free medusæ.

Genus STEGOPOMA.

Trophosome.—Hydrothecæ with the distal ends beveled on opposite sides and the aperture closed with an operculum composed of numerous segments, the whole resembling an A tent.

This genus, proposed originally by Prof. G. M. R. Levinsen[a], seems to me to be practically convenient, whether a natural one or not, and it is therefore adopted in this paper. There is no character used in connection with the gonosome.

Stegopoma gilberti Nutting, new species.

(Pl. III, fig. 1; pl. IX, fig. 1.)

Trophosome.—Colony attaining a height of 6 inches or more. Stem and branches fascicled, branches irregularly alternate and themselves often giving off irregularly disposed branchlets. Pedicels arising irregularly from the peripheral tubes of the fascicled stem and branches. Hydrothecæ very large and slender, their bases passing insensibly into the pedicels, which are not more than one and a half times as long as the hydrothecæ; margin cut away on opposite sides so as to be strongly beveled, the beveled sides being fitted with opercula, which are split up into many narrow, ribbon-like

[a] Meduser, Ctenophorer og Hydroider fra Grönlands Vestkyst, Copenhagen, Særtryk af Vidensk. Meddel. fra den naturk. Foren, 1892, 35.

strips and meet in a ridge-like line above. The reduplication of the margin often complicates the structure of the operculum, which is then itself duplicated. Bottom of the hydrotheca with a distinct septum. Hydranths long and slender, with about 16 tentacles and a conical proboscis.

Gonosome.—Gonangia rather shorter than the hydrothecæ and nearly sessile, slender, narrowing very gradually below and ending in an operculate margin much like that of the hydrothecæ. Blastostyle bearing several male gonophores.

Distribution.—Station 4102, between the islands of Maui and Molokai, 122 fathoms.

Stegopoma gracilis Nutting, new species.

(Pl. III, fig. 2; pl. VIII, figs. 8, 9.)

Trophosome.—Colony parasitic. Pedicels springing from a nonfascicled creeping stolon. Hydrothecæ much smaller than the preceding, but otherwise almost a miniature of *S. gilberti*.

Gonosome.—Gonangia springing from rootstock, stout, decidedly longer than the hydrothecæ, the margin and operculum as in the hydrothecæ.

Distribution.—Station 4000, south of Kauai Island, 213 fathoms, station 4098, north coast of Maui Island, 95 fathoms, station 4101, between Maui and Molokai islands, 143 fathoms.

The entirely different habit of this species and its constant difference in size seem to sufficiently distinguish it from the preceding.

Stegopoma plumicola Nutting, new species.

(Pl. III, fig. 3; pl. IX, figs. 2, 3.)

Trophosome.—Colony parasitic on *Lytocarpus phœniceus* and consisting of sessile hydrothecæ borne on a creeping stolon. Hydrothecæ smaller and more robust than in *S. gilberti*, four or five times as long as wide, the ends beveled on opposite sides so as to form 2 long, broad, pointed teeth, between which the operculum, consisting of many narrow strips, is placed.

Gonosome.—Gonangia sessile on the rootstock, decidedly longer than the hydrothecæ margin, circular, but with a two-flapped operculum in the shape of an A tent.

Locality.—Station 3939, northwest of the island of Laysan 163 fathoms.

Genus **OPERCULARELLA**.

Trophosome.—Stem not fascicled. Hydrothecæ ovate in outline, the margin not distinct, its distal portion being produced into a number of narrow pointed strips which converge to form a conical operculum.

Gonosome.—The mature gonangia bear acrocysts.

? **Operculariella longicauda** Nutting, new species.

(Pl. III, fig. 5; pl. IX, figs. 4–7.)

Trophosome.—Colony parasitic on another hydroid, growing in tufts of pedicels from a creeping rootstock. Pedicels very long and slender, not annulated even at ends, sometimes five times as long as the hydrothecæ. Hydrothecæ small terete, very thin and collapsible, distal ends broken up into a many-parted operculum which sometimes introverts as in *Calycella syringa*.

Gonosome.—Gonangia borne on the rootstock, very large in comparison with the size of the hydrothecæ, deep urn-shaped with flaring campanulate margin and a flat operculum composed of several well-marked segments. The single gonangium found almost certainly belongs to this species, being found buried among the pedicels of the hydrothecæ. In dissecting the rubbish in which it was imbedded, the short pedicel broke before the connection with the rootstock from which the hydrothecæ sprung was proved.

Locality.—Station 3859, between Molokai and Maui islands, 138 fathoms.

Genus **CALYCELLA**.

Trophosome.—Stem a creeping parasitic rootstock. Hydrothecæ with a distinct margin, above which is a distinct, many-parted operculum which is often introverted.

Gonosome.—Gonangia borne on the rootstock, oval, and bearing globular acrocysts when mature.

Calycella syringa (Linnæus).

Locality.—Station 4098, north coast of Maui Island, 95 fathoms.

This is the only specimen of this well-known species that I have found in the collection.

Sertularia syringa Linnæus, Syst. Nat., 1311, 1767.

Family LAFOËIDÆ.

Trophosome.—Stem fascicled, consisting of an axial and several peripheral tubes, or else simple and consisting of a creeping rootstock. Hydrothecæ tubular, without operculum. Hydranths with a conical proboscis.

Gonosome.—Gonangia aggregated in groups or masses called "coppinia" masses. This family was described by Hincks in 1868. In 1888 Allman, in his Challenger Report, instituted the family Perisiphonidæ, in which the first or type genus was *Lafoëa*, the type of Hincks's family Lafoëidæ. This latter fact justifies us in retaining the family Lafoëidæ, modified, however, by the introduction of the character of the stem, which was first fully appreciated by Allman.

Genus LAFOËA.

Trophosome.—Stem polysiphonic. Hydrothecæ tubular, without diaphragm, and never adnate to the axial tube.

Gonosome.—A true "coppinia" mass, gonangia flask-shaped, with a single terminal aperture.

Lafoëa dumosa (Fleming).

This widely distributed species was found at three stations, namely: Station 3824, south coast of Molokai Island, 228–498 fathoms; station 3859, between the islands of Molokai and Maui, 138 fathoms; station 4101, between the islands of Maui and Molokai, 143 fathoms.

Sertularia dumosa Fleming, Edinburgh Phil. Jour., 1820, II, 83.

Lafoëa fruticosa (Sars).

Fine specimens of this species, with the gonosome well developed, were secured at station 4079, near Maui Island, 143 fathoms. Others were secured at station 4066, northeast coast of Hawaii Island, 176 fathoms, and at station 4077, between Hawaii and Maui islands, 99 fathoms.

"*Campanularia fruticosa*" Sars, Reise i Lofoten og Finmarken, 18, 1850.

Lafoëa contorta Nutting, new species.

(Pl. III, fig. 6; pl. IX, figs. 8, 9.)

Trophosome.—Colony parasitic, growing from a twisted rootstock. Hydrothecæ sessile, tubular, very long, and often bent and twisted in various ways; aperture round; margin slightly everted and often many times reduplicated. No operculum nor hydrothecal septum.

Gonosome.—Not known.

Distribution.—Station 3949, north of Laysan Island, 59 fathoms; station 4102, between the islands of Maui and Molokai, 122 fathoms.

The hydrothecæ are longer in proportion to their width in this species than in any other that I have seen, and the extent of reduplication of the margins imparts a highly ornamental effect.

Genus LICTORELLA.

Trophosome.—Stem fascicled. Hydrothecæ pedunculate, never adnate to the axial tube, diaphragm usually present. Nematophores often found on branches just below the hydrothecæ.

Gonosome.—Gonangia aggregated, with curiously protuberant "shoulders" on one or two sides of the distal end. These are horn-like processes which may curve upward, or downward, or be directed straight outward, according to the species.

Lictorella halecioides (Allman).

(Pl. x, figs. 1–4.)

Gonosome.—(Not heretofore described.) Gonangia forming a true "coppinia" mass, obovate in general form, with one shoulder produced into a conspicuous hook that bends over the gonangium. The gonangia are firmly adherent, the connection not being dissolved by boiling in potash. Fig. 1, pl. x, shows a cross section of the mass and stem, and also the connection between some of the gonangia and the component tubes of the stem. The hook is much broader in front view than in its lateral aspect, as shown in figs. 2–4.

This is one of the most abundant species in the collection, being found at station 3854, south coast of Molokai Island, 134 fathoms; station 3856, between the islands of Molokai and Maui, 127 fathoms; station 3859, between the islands of Molokai and Maui, 138 fathoms; station 3863, between the islands of Molokai and Maui, 127 fathoms; station 3936, north of the island of Laysan, 130 fathoms; station 3939, north of the island of Laysan, 163 fathoms; station 4098, north coast of Maui Island, 95 fathoms.

Lafœa halecioides Allman, Hydroida of the *Porcupine* Expedition, Trans. Zool Soc., Vol. VIII, 1873, 472.

Lictorella cervicornis, new species.

(Pl. iv, fig. 1; pl. x, figs. 5–9.)

Trophosome.—Colony flabellate, small, very delicate and graceful, attaining a height of about an inch and a quarter. Main stem and larger branches fascicled. Branches subalternate, most of them monosiphonic, sinuous, divided into regular internodes, each of which bears a strong process near its middle from which a pedicel springs. Hydrothecæ deep, tubular, cyathiform, projecting forward and outward, ending in a round aperture with even margin, the proximal end passing insensibly into the pedicel from which it is separated by an internal diaphragm. At the base of each pedicel there is a true nematophore containing a sarcostyle and a nematocyst battery.

Gonosome.—Gonangia forming a "coppinia" mass on the main stem, roughly triangular in outline, the distal ends being the broader on account of the opposite shoulders, which are quite conspicuous and end in round apertures. Midway between these shoulders there is a short neck ending in a third aperture. The individual gonangia are borne on short branchlets, which continue beyond them, arching over each gonangium so as to form a protecting network of such branches over the aggregated gonangia. This structure seems to resemble quite closely the phylactogonia found in certain genera of plumularian hydroids.

Locality.—Station 3859, between the islands of Molokai and Maui, 138 fathoms.

This is one of the most beautiful and graceful hydroids that I have seen. The gonosome is unique in certain features, but the species doubtless belongs in the genus *Lictorella*. The nematophores are indistinguishable from some of those found in the Plumularidæ.

Genus FILELLUM.

Trophosome.—Colony parasitic, growing from a creeping rootstock. Hydrothecæ tubular, greatly curved, the distal portion being adnate to the stem or to the host.

Gonosome.—Gonangia forming a true "coppinia" mass, much as in the genus *Lafoëa*.

Filellum serpens (Hassell).

Specimens of this well-known form were noticed while other species were being examined, but the species and station numbers were not noted at the time, and I have been unable to find them on going over the collection again. I am confident that I saw them, and it can be readily understood that they could well be overlooked in going over such a quantity of material a second time.

Campanularia serpens Hassell, Zoologist, Vol. VI, 1848, No. 69, 2223.

Genus CRYPTOLARIA.

Trophosome.—Stem fascicled, with an axial and peripheral tubes. Hydrothecæ without peduncles, and adnate to some extent, at least in the distal parts of the branches.

Gonosome.—A compact "coppinia" mass, much as in *Lafoëa*.

This genus was originally defined by Busk. Allman revised it in his Challenger Report, page 37, as having scattered, sac-like gonangia. In 1900 Bedot, in his "Hydraires provenant des campagnes de l'Hirondelle," page 21, describes an allied form, *Perisiphonia pectinata* Allman, which has a true "coppinia" mass and also a few scattered gonangia. He suggests that these latter may be gonangia of a different sex from those in the "coppinia" mass, and cites my own description of the gonosome of *Lafoëa dumosa*, in which the two sexes are present in the same colony.[a]

This author also describes the gonosome of *Cryptolaria conferta* Allman, which is a true "coppinia" mass, and which Allman himself described, but afterwards considered as a parasitic organism not belonging to the species on which it was found.[b]

Cryptolaria pulchella Allman.

This is one of the most abundant species in the collection. It was originally found in the *Challenger* collection, dredged near Honolulu.

Distribution.—Station 3809, south coast of Oahu Island, 125 fathoms; station 3814, off Diamond Head, near Honolulu, 284 fathoms; station 3848, south coast of Molokai Island, 73 fathoms; station 3849, south coast of Molokai Island, 73–43 fathoms; station 3858, between Molokai and Maui islands, 128 fathoms; station 3859, between Molokai and Maui islands, 138 fathoms; station 3863, between Molokai and Maui islands, 127 fathoms; station 4068, northeast coast of Maui Island, 18 fathoms; station 4098, north coast of Maui Island, 95 fathoms; station 4101, between the islands of Maui and Molokai, 143 fathoms.

Cryptolaria pulchella Allman, *Challenger* Report, The Hydroida, Part II, 40, 1888.

Cryptolaria symmetrica Nutting, new species.

(Pl. IV, fig. 2; pl. X, figs. 10, 11.)

Trophosome.—Colony attaining a height of about 7 inches. Stem and branches fascicled throughout, main branches irregularly disposed, but on opposite sides of the stem, ultimate branches subopposite, the whole structure being flabellate in form. Accessory tubes reaching to the tips of the ultimate branches. Hydrothecæ springing from the axial tube and projecting between the accessory tubes, their distal ends curving gracefully outward, regularly alternating. The hydrothecæ on the distal parts of the branches are without reduplication of margins; those on other parts of the colony have the margins extensively reduplicated, giving an appearance of extensive annulations. The hydrothecæ are much smaller than in other species of the genus that I have seen, are slender and graceful, and symmetrically disposed.

Gonosome.—Unknown.

Distribution.—Station 3854, south coast of the island of Molokai, 134 fathoms; station 3863, between the islands of Molokai and Maui, 127 fathoms; station 3871, between the islands of Molokai and Lanai, 13 fathoms; station 3987, north of the island of Kauai, 55 fathoms; station 4079, north of the island of Maui, 143 fathoms; station 4100, between the islands of Maui and Molokai, 130 fathoms; station 4135, north of the island of Kauai, 225 fathoms.

This species is of a golden yellow color and is one of the prettiest in the collection. By clearing with potash the connection between the hydrothecæ and the axial tube can be demonstrated, as well as the fact that the hydrothecæ are partly adnate.

?**Cryptolaria operculata** Nutting, new species.

(Pl. III, fig. 4; pl. X, figs. 12–14.)

Trophosome.—Colony (incomplete) about 2 inches high, flabellate in form. Stem and all but ends of ultimate branches fascicled, the tubes being continuous with the cavities of the hydrothecæ, there being no diaphragms nor pedicels. Branches irregularly disposed, the ultimate ones being subalternate. Hydrothecæ tubular, curved, varying greatly in the extent of immersion and equal in caliber throughout; margins very thin and collapsible, ending in two opposite broad points, and

[a] Proc. U. S. Nat. Mus., Vol. XXI, 1899, 751.

[b] See Allman, Hydroids of the Gulf Stream, p. 17, 1877; and Challenger Report, The Hydroida, Part II, 38, 1888.

supporting a bivalve operculum, the structure of which is so delicate as to be hard to decipher, the appearance being that of the operculum of the genus *Stegopoma*.

Gonosome.—Not known.

Distribution.—Station 3859, between the islands of Molokai and Maui, 138 fathoms.

It is likely that a separate genus should be instituted for this species and *Cryptolaria geniculata* Allman [a], both of which differ from all other known members of the genus in having a well-marked operculum.

Family SERTULARIDÆ.[b]

Trophosome.—Hydranths with a conical proboscis. Hydrothecæ sessile, adnate, or partly embedded in the hydrocaulus, arranged definitely in more than a single row. An operculum of less than five parts almost always present. Nematophores wanting.

Gonosome.—Gonophores always inclosed in gonangia and never producing medusoid forms.

Genus SERTULARIA.

Trophosome.—Hydrothecæ in opposite or subopposite pairs, each pair being normally borne on a separate internode of the hydrocaulus. Operculum normally of two flaps.

Gonosome.—Gonangia oval or ovate, with a short collar and broad aperture, and no internal marsupium.

Sertularia snyderi Nutting, new species.

(Pl. IV, fig. 5; pl. X, fig. 15.)

Trophosome.—Colony unbranched, attaining a height of about one-third of an inch. Stem simple, straight, slender, with nodes obscure or absent, but when evident about midway between the pairs of hydrothecæ. Hydrothecæ exceedingly slender, strictly opposite, but borne on front of stem, somewhat pistol-shaped, the butt of the pistol representing the proximal portion of the hydrotheca, the inner side of which is contiguous with its fellow, the distal three-fourths being free and bent outward nearly at a right angle with the stem. Aperture with two large opposite teeth and a minute superior tooth. Operculum very delicate, but apparently of two valves.

Gonosome.—Not known.

Locality.—Station 3939, northwest of the island of Laysan, 163 fathoms.

This species has the most slender hydrothecæ that I have seen in the genus. It was found growing as a parasite on a plumularian hydroid.

Genus SERTULARELLA.

Trophosome.—Hydrothecæ biserial, strictly alternate, with an operculum almost always composed of 3 or 4 strong triangular segments.

Gonosome.—Gonangia usually ornamented with annular ridges or corrugations. Aperture at the end of a trumpet-shaped tube, or else surrounded by blunt spines or nodules.

Sertularella lata (Bale).

Distribution.—Station 3848, south coast of the island of Molokai, 44 fathoms; station 3854, south coast of the island of Molokai, 134 fathoms.

Thuiaria lata Bale, Catalogue of the Australian Hydroid Zoophytes, 129, 1884.

Sertularella dentifera Torrey.

(Pl. XI, fig. 1.)

Gonosome.—(Hitherto undescribed.) Gonangia ovate, strongly annulated throughout, and with a very small tubular neck around which a collar arises.

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[a] *Challenger* Report, The Hydroida, Part II, p. 41, 1888.

[b] The classification of genera in this family and in the Plumularidæ is the same as that adopted in the author's monograph, "American Hydroids," Parts I and II, published by the U. S. National Museum as Special Bulletin No. 4. The definitions used in the present work are somewhat abridged, but practically the same.

Distribution.—Station 3818, off Diamond Head, near Honolulu, 293 fathoms; station 3854, south coast of Molokai, 134 fathoms; station 3863, between the islands of Molokai and Maui, 127 fathoms; station 3968, near French Frigate Shoal, 14½ fathoms; station 4101, between the islands of Molokai and Maui, 143 fathoms; station 4102, between the islands of Molokai and Maui, 122 fathoms.

Sertularella dentifera Torrey, Hydroids of the Pacific coast of North America, 61, 1902.

Sertularella torreyi Nutting, new species.

(Pl. IV, fig. 4; pl. XI, figs. 2, 3.)

Trophosome.—Colony (incomplete) attaining a height of about 2 inches. Stem not fascicled, divided into regular internodes each of which bears a branch and 2 hydrothecæ on one side and a single hydrotheca on the other. Branches regularly alternate, not divided into internodes. Hydrothecæ immersed nearly to their apertures, moderately distant; margins with 2 opposite lateral teeth and hardly a sign of the other 2; valves of the operculum not constant in number.

Gonosome.—Gonangia borne on main stem, very deeply urceolate, with slightly flaring, campanulate margin marked by a series of broad sinuations which correspond to broad, shallow longitudinal corrugations reaching from the margin about halfway down the sides of the gonangia. Aperture exceedingly broad, sometimes furnished with a membranous operculum which is irregularly ruptured for the escape of the sexual elements.

Distribution.—Station 3949, south coast of the island of Molokai, 70 fathoms; station 4003, off the island of Kauai, 751–406 fathoms.

The gonangia of this species are of very exceptional form for the Sertularidæ. I know of no other species of *Sertularella* with this type of gonangia, a type not infrequently found among the Campanularidæ.

Sertularella crenulata Nutting, new species.

(Pl. IV, fig. 3; pl. XI, figs. 4–7.)

Trophosome.—Colony about 3 inches high. Stem and proximal part of main branches fascicled, distal parts of branches monosiphonic. Branches alternate, moderately geniculated. Hydrothecæ rather long, curving gently outward and ending in a square margin and a 4-flapped operculum. The whole body of the hydrotheca is closely and evenly annulated with fine rugosities which are clear-cut and evenly distributed, making a very striking and beautiful ornamentation.

Gonosome.—Gonangia oval, strongly annulated throughout, and with an aperture surrounded by 4 unequal points or teeth. The gonangia are aggregated on the distal parts of the colony.

Distribution.—Station 3848, south coast of the island of Molokai, 44 fathoms; station 3854, south coast of Molokai, 134 fathoms.

This is a very striking and beautiful species, and is more closely annulated than any other of the genus that I have seen.

Genus PASYTHEA.

Trophosome.—Hydrothecæ strictly opposite, arranged in groups of pairs, a group to an internode, the upper pair being smaller and differing in shape from the lower; margin bilabiate, with a 2-flapped operculum.

Gonosome.—Gonangia oval, aperture large, collar round and narrow.

Sertularia quadridentata, Ellis & Solander, Nat. Hist. Zooph., 1786, 57.

Pasythea quadridentata Ellis and Solander.

Specimens of this widely distributed species were taken at station 3968, where the depth was 14½ fathoms, but as they were attached to pelagic algæ they probably came from the surface. The station was near French Frigate Shoal.

Genus THUIARIA.

Trophosome.—Hydrothecæ subopposite to alternate, more than two to an internode, margin smooth or with 1 or 2 teeth, operculum with 1 abcauline flap (very exceptionally with 2 flaps). Hydrothecæ usually more or less immersed.

Gonosome.—Gonangia oval, with large terminal aperture, and with 1 or 2 spines or horns at the shoulders.

Thuiaria fenestrata Bale.

Distribution.—Station 3955, north of Laysan Island, 20 fathoms; station 4068, northeast of Maui Island, 14 fathoms.

Thuiaria fenestrata Bale, Catalogue of the Australian Hydroid Zoophytes, 116, 1884.

Genus DIPHASIA.

Trophosome.—Hydrothecæ biserial, opposite or alternate, aperture broad, operculum evident and consisting of a single adcauline flap.

Gonosome.—Gonangia usually with an internal marsupium and often marked with spines or lobes on its distal portion.

Diphasia palmata Nutting, new species.

(Pl. IV, fig. 6; pl. XI, figs. 8–10.)

Trophosome.—Colony attaining a height of about 1 inch. Stem not fascicled, smooth without nodes or hydrothecæ for some distance, breaking suddenly into a number of widely divergent branches, which again divide into branchlets, all being in the same plane. Branches with very faint nodes just above the hydrothecæ. Hydrothecæ much as in *D. rosacea*, opposite, tubular, their proximal three-fourths vertical and parallel, their distal portions being bent abruptly outward. Margin even. Operculum of a single strong adcauline flap.

Gonosome.—Gonangia (female) borne in rows on front of branches, each composed of four very unequal gonangial leaves, one of which is much longer and broader than the others, imparting a very unsymmetrical appearance to the whole gonangium. Leaves notched near their ends in some cases. There is an evident internal marsupium of the type characteristic of the genus.

Locality.—Station 3854, south coast of the island of Molokai, 134 fathoms.

This is a well-marked species of a genus that has no other typical representative this far to the south, so far as I know. The manner of branching is very unusual in *Diphasia*.

Genus SYNTHECIUM.

Trophosome.—Branches opposite, with regular nodes. Hydrothecal margins smooth, round, often rimmed or reduplicated. Operculum apparently wanting.

Gonosome.—Gonangia springing from the interior of hydrothecæ, where they replace hydranths.

Synthecium tubithecum (Allman).

Distribution.—Station 3819, south coast of the island of Molokai, 70 fathoms; station 4053, northeast coast of the island of Hawaii, 29 fathoms.

This species has not before been reported from the Pacific.

Sertularia tubitheca Allman, Mem. Mus. Comp. Zool., Vol. V, 1877, No. 2, 24.

Synthecium orthogonia (Busk).

Locality.—Station 4068, northeast coast of Maui Island, 14 fathoms.

But a single fragmentary specimen was found. It agrees well with the figure and description given by Bale (proceedings of the Linnæan Society of New South Wales, 1888, page 767).

Sertularia orthogonia Busk, Voyage of *Rattlesnake* (Narrative, Appendix IV, 1852).

Family PLUMULARIDÆ.

Trophosome.—Hydrothecæ adnate to hydrocaulus and on one side only of hydrocladia. Hydranths with a conical proboscis and a single whorl of filiform tentacles.

Gonosome.—Gonangia often inclosed in corbulæ, or protected by special nematophorous branches. Medusæ never produced.

Genus PLUMULARIA.

Trophosome.—Cœnosarc of stem not canaliculated, hydrocladia unbranched, hydrothecæ with smooth margins, nematophores always movable, not adnate.

Gonosome.—Gonangia simple sac-shaped or bottle-shaped.

Plumularia corrugata Nutting.

Locality.—Station 4102, north coast of the island of Maui, 122 fathoms.

This specimen agrees closely with those collected by Richard Rathbun off the coast of Brazil.

Plumularia corrugata Nutting, American Hydroids, 1900, Part I, 64.

Plumularia jordani Nutting, new species.

(Pl. VI, fig. 5; pl. XII, figs. 1–2.)

Trophosome.—Colony dark in color, rigid in habit, flabellate in form; main stem fascicled, strongly geniculate; branches arising from peripheral tubes, nearly straight, fascicled proximally, simple distally, bearing pinnate branchlets which, like the distal parts of main branches, are divided into regular internodes, each of which bears a hydrocladium on a strong process near its distal end, the process showing a conical protuberance on its upper side. Hydrocladia subalternate, those on each side being alternately raised and depressed, as viewed under the lens, so that the hydrocladia on each side occupy two distinct planes, a very exceptional character. Hydrocladia divided into regularly alternating hydrothecate and intermediate internodes, the former being about twice as long as the latter and bearing hydrothecæ just below their middle. Hydrothecæ small, cylindrical, margin even, scarcely flaring. Nematophores large in proportion to the hydrothecæ, the supracalycine pair arising from a point above the hydrothecal margin; a mesial nematophore on the proximal end of each hydrothecate internode, another near the proximal end of each intermediate internode, and a pair on the upper side of each of the processes from the stem or branch supporting hydrocladia, these being the only cauline nematophores. Hydranths very large, not capable of retracting within the hydrothecæ.

Gonosome.—Not known.

Locality.—Station 3936, near the island of Laysan, 79 to 130 fathoms.

This species is unique among the Plumularidae in the disposition of the hydrocladia in two planes on each side, and is of a peculiarly stiff and rigid habit, and the main stem is more plainly geniculate than in any other species of the genus with which I am acquainted.

Plumularia delicata Nutting, new species.

(Pl. V, fig. 2; pl. XII, figs. 3–5.)

Trophosome.—Colony attaining a height of about 6 inches. Stem simple, divided into regular internodes each of which bears a hydrocladium from a process near its distal end. Hydrocladia divided into alternating hydrothecate and intermediate internodes, each of which has an internal chitinous thickening near each end and all of which are longer than in allied species, the hydrothecate internodes being about twice as long as the others and bearing the hydrothecæ a little above their middle. Hydrothecæ cup-shaped, about as high as broad, anterior profile straight. Nematophores large, a supracalycine pair and 2 mesial ones to each hydrothecate internode, and 2 mesial ones to each intermediate internode.

Gonosome.—Gonangia bottle-shaped, but stouter than those of *P. setacea*, borne on front of stem.

Distribution.—Station 3842, south coast of Molokai, 495 fathoms; station 4072, north coast of the island of Maui, 56 fathoms.

This species is nearest to *P. palmeri* Nutting, but differs in bearing 2 mesial nematophores, instead of 1, on each internode of the hydrocladia; and in having much longer intermediate internodes.

Plumularia milleri Nutting, new species.

(Pl. V, fig. 1; pl. XII, figs. 6, 7.)

Trophosome.—Colony attaining a height of about 1 inch. Stem not fascicled, divided into regular internodes each bearing a hydrocladium from a strong process near its distal end. Hydrocladia divided into alternating hydrothecate and intermediate internodes, the former being considerably the longer and bearing hydrothecæ a little above their middle; all internodes showing internal thickenings near each end, the thickenings appearing at first sight much like corrugations. Hydrothecæ as in *P. setacea*, but more distant. Nematophores very loosely attached and often wanting, the supracaly-

cine pair originating near the top of hydrothecæ, a mesial one at base of each hydrotheca, and another in the middle of each intermediate internode; a pair of cauline nematophores in the axil of each hydrocladium, and others irregularly placed on the stem.

Gonosome.—Gonangia very long, slender, delicate, curving gently at distal end and tapering gradually to the round terminal aperture. The gonangia are not in an upright position, as in allied species, but project so as to be parallel with the hydrocladia.

Locality.—Station 4098, north coast of the island of Maui, 95 fathoms.

This species is unique, I believe, in the regularly horizontal position of the gonangia.

Genus MONOSTÆCHAS.

Trophosome.—Colony branched, the hydrocladia being borne on the upper sides of the branches. No cauline nematophores.

Gonosome.—Gonangia ovate, without protective branches of any kind.

Monostæchas quadridens (McCrady).

Distribution.—Station 3854, south coast of the island of Molokai, 134 fathoms; station 3859, between the islands of Molokai and Maui, 138 fathoms.

I am unable to separate these specimens from others from our Atlantic coast, the only perceptible difference being somewhat shorter nematophores in the specimens from the Hawaiian region.

Plumularia quadridens McCrady, Gymnophthalmata of Charleston Harbor, 1857, 97.

Monostæchas fisheri Nutting, new species.

(Pl. v, fig. 3; pl. xii, fig. 8.)

Trophosome.—Colony growing from a straggling root-stock and attaining a height of three-quarters of an inch. Stem monosiphonic, smooth, with distinct but irregular nodes. Branches sometimes alternate and sometimes opposite, but always on opposite sides of the stem. Hydrocladia arising from upper sides of branches, divided into regularly alternating hydrothecate and intermediate internodes of nearly equal length; nodes alternately straight and oblique, the former being above and the latter below the hydrothecæ. Hydrothecæ very large for this group, cup-shaped, thin-walled, with a slightly flaring margin and the adcauline wall almost entirely free from the hydrocladium. There are no cauline hydrothecæ. Supracalycine nematophores borne on very slender horn-like processes from the hydrocladium; 2 mesial nematophores to each intermediate internode, and 2 (1 immediately above and 1 below the hydrotheca) on each hydrothecate internode.

Gonosome.—Gonangia borne on the hydrocladia at bases of hydrothecæ, obovate in form, as in *M. quadridens.*

Distribution.—Station 3936, off Laysan Island, 79 to 130 fathoms; station 3949, off Laysan Island, 59 to 152 fathoms; station 4072, northeast coast of the island of Maui, 56 fathoms.

The hydranths of this species are colored almost black by a dark pigment resembling that found in many species of *Lytocarpus.*

Genus ANTENNELLA.

Trophosome.—Colony consisting of hydrocladia springing direct from a creeping root-stock, without a true stem. Hydrocladia and hydrothecæ as in the preceding genus.

Gonosome.—Gonangia pyriform, aperture distal, round.

Antennella complexa Nutting, new species.

(Pl. v, fig. 4; pl. xii, fig. 9.)

Trophosome.—Colony sometimes attaining a height of about 4 inches. Creeping root-stocks intertwined so as to resemble closely a fascicled stem from which the hydrocladia arise in great profusion, but with no regularity of arrangement whatever. All of these parallel root-stocks bear hydrocladia and are closely appressed to each other, but are easily separated with the needles.

Hydrocladia disposed on all sides of this pseudo-stem, divided into alternating hydrothecate and intermediate internodes of approximately equal length, although there is much variation in this

particular, the hydrothecate internodes ending in a straight upper and an oblique lower node and bearing a hydrotheca near the middle or a little below. Hydrothecæ rather deep cup-shaped, margin even, about half of adcauline side free from the hydrocladium.

Supracalycine nematophores scarcely reaching the hydrothecal margin; 4 to 6 mesial nematophores between adjacent hydrothecæ.

Gonosome.—Gonangia pyriform, with a round margin, large terminal aperture and 2 nematophores on the short pedicel. They are borne at the bases of the hydrothecæ.

Localities.—Station 3854, south coast of the island of Molokai, 30 fathoms; station 3859, between the islands of Molokai and Maui, 138 fathoms.

This species is of peculiar interest, as it shows the manner of forming a stem by the aggregation of root-stocks. I have elsewhere shown that the peripheral tubes of the fascicled stem in many species are formed by modified hydrocladia.[a]

The student of the Hydroida is continually having the extreme plasticity of these organisms forced upon his attention, and this plasticity, with its complementary lack of fixity, is the cause of untold confusion in the systematic discussion of the group.

Genus AGLAOPHENIA.

Trophosome.—Hydrothecal margin dentate; a posterior intrathecal ridge present; 3 nematophores attached to each hydrotheca.

Gonosome.—Gonangia inclosed in true corbulæ, the leaves of which do not bear hydrothecæ at their bases.

? Aglaophenia rigida Allman.

A single fragmentary specimen, without gonosome, found at station 4072, north coast of the island of Maui at a depth of 52 fathoms, is referred, with considerable doubt, to this species. Another fragment was secured at station 3847, south coast of Molokai Island, 23 fathoms.

Aglaophenia rigida Allman, Mem. Mus. Comp. Zool., V, 1877, No. 2, 43.

Genus THECOCARPUS.

Trophosome.—Stem fascicled, hydrothecæ toothed, nematophores attached to the hydrothecæ.

Gonosome.—Corbula composed of separated leaves, each of which bears a hydrotheca near its base on its outer side. More than one hydrotheca between the corbula and the stem.

Thecocarpus niger Nutting, new species.

(Pl. v, fig. 5; pl. xiii, figs. 1–6.)

Trophosome.—Colony black in color, attaining a height of about 6 inches. Stem fascicled, proximal portion unbranched, distal part giving off a number of irregularly disposed large branches which themselves often branch in an irregular manner; smaller branches not fascicled, and the internodes not apparent unless the specimen is boiled in potash, when a regular division into short nodes divided by oblique internodes is apparent. Hydrocladia alternate, borne on front of stem and branches, divided into regular internodes, each of which bears a hydrotheca and shows an internal chitinous ridge at about its middle. Hydrothecæ ovoid in shape, margin with about 10 irregular jagged teeth, the points of which turn inward, the anterior one forming a horn-like projection rising somewhat above the others; intrathecal ridge low and straight, nearly horizontal. Supracalycine nematophores horn-like, not very large, rising about to the top of the hydrotheca; mesial nematophore arising above the middle of the hydrotheca, projecting outward and upward, not attaining the level of the top of the hydrotheca, and with two apertures; cauline nematophores large, 2 at the base of each hydrocladium.

Gonosome.—Gonangia contained in a corbula bearing a close resemblance to that characteristic of *Aglaophenia*, but really of the *Thecocarpus* type. It is very large, gracefully arched, with the concave side upward, composed of 18 to 20 pairs of corbula leaves, each of which bears a hydrotheca near its base on the outside and 2 rows of large tubular nematophores with conspicuous nematocysts. The last 2 or 3 pairs of leaves are represented by hydrothecæ alone, and 1 or 2 hydrothecæ are found on the stem between the first true corbula leaf and the stem from which the corbula springs.

[a] American Hydroids, Part II, p. 5, 1904.

Distribution.—Station 3939, north of the island of Laysan, 163 fathoms; station 3955, northeast of the island of Laysan, 20 fathoms; station 3961, south of the island of Laysan, 19 fathoms; station 3962, south of the island of Laysan, 16 fathoms.

This remarkable species is represented by a number of fine specimens from the waters about Laysan. The corbula is so much like that of *Aglaophenia* in external appearance that it would deceive anyone who did not carefully investigate it. The trophosome also is almost that of a typical *Aglaophenia*. The black color is constant in all the specimens and is produced by a dense black pigment throughout the colony.

Genus LYTOCARPUS.

Trophosome.—Stem fascicled; hydrothecal margin strongly toothed or sinuous; mesial nematophores with 2 openings, cauline nematophores broad and triangular in outline.

Gonosome.—Gonangia borne on hydrocladia, which are modified so as to form protective branchlets, often aggregated into a pseudo-corbula, with leaves formed by modified hydrocladia instead of appendages to hydrocladia, as in the genus *Aglaophenia*. There is a hydrotheca at the base of each protective branch.

Lytocarpus phœniceus (Busk).

This is one of the most common species in the collection, being found at the following stations: Station 3809, south coast of the island of Oahu, 125 fathoms; station 3814, off Diamond Head, Oahu, 284 fathoms; station 3845, south coast of the island of Molokai, 60 fathoms; station 3848, south coast of the island of Molokai, 73 fathoms; station 3849, south coast of the island of Molokai, 73 fathoms; station 3939, north of the island of Laysan, 163 fathoms; station 3978, south of Bird Island, 32 fathoms; station 3979, south of Bird Island, 222 to 387 fathoms; station 3987, north of the island of Kauai, 55 fathoms; station 4071, north of the island of Maui, 52 fathoms; station 4072, north of the island of Maui, 56 fathoms.

Plumularia phœnicea Busk, Voyage of the *Rattlesnake*, Narrative, Appendix IV, 1852.

Lytocarpus hawaiensis Nutting, new species

(Pl. v, fig. 6; pl. xii, figs. 10–13.)

Trophosome.—Colony attaining a height of about 4 inches. Stem fascicled; branching pinnate, the branches distant and not fascicled, not plainly divided into internodes, bearing the alternate hydrocladia. Hydrothecæ ovate in general outline, margin with a rather prominent anterior tooth and 2 small uneven lateral teeth on each side; intrathecal ridge obsolete. Supracalycine nematophores strong, regularly curved, reaching considerably above the hydrothecal margin; mesial nematophores moderate in size, regularly curved outward, and not nearly reaching the top of the hydrotheca; cauline nematophores very long and slender, 2 on the branch at the base of each hydrocladium.

Gonosome.—Gonangia borne on branches which are modified into protective contrivances taking the form of sickle-shaped phylactogonia, 1 to each of the much-flattened gonangia. Gonangia borne on rows on the upper side of the branch, orbicular, but considerably broader than long when viewed from the flat side. The phylactogonia are armed with 2 rows of long conspicuous tubular nematophores.

Distribution.—Station 3853, south coast of Molokai Island, 115 fathoms; station 3875, between Maui and Lanai islands, 65 fathoms; station 3848, south of the island of Molokai, 44–73 fathoms.

Lytocarpus balei Nutting, new species.

(Pl. vi, fig. 1; pl. xiii, figs. 7, 8.)

Trophosome.—Colony attaining a height of about 2 inches. Stem fascicled; branches irregularly alternate and fascicled, except on the distal parts; hydrocladia alternate, each with 2 strong septal ridges and 1 weak one opposite each hydrotheca. Hydrothecæ oval in general outline, aperture nearly vertical, margin almost smooth, and a very strong intrathecal ridge usually reaching more than halfway across the hydrotheca and ending in a round knob. Supracalycine nematophores small, slender, reaching nearly to the hydrothecal margin; mesial nematophores very strong, and reaching considerably above the hydrothecal margin.

Gonosome.—Gonangia borne on specialized hydrocladia with one or more hydrothecæ at their bases, bean-shaped, arranged in 2 rows. The distal part of each of these specialized hydrocladia is curved and armed with strong nematophores, but without hydrothecæ. They alternate irregularly with ordinary hydrocladia, the tendency being to an arrangement in which there are 2 ordinary hydrocladia between adjacent phylactogonia.

Locality.—Station 3852, off the south coast of Molokai, 47 to 115 fathoms.

This is the smallest species of *Lytocarpus* found in the collection. It seems to be a very well-marked species, especially in its gonosome.

Lytocarpus similis Nutting, new species.

(Pl. VI, fig 3; pl. XIII, figs. 9, 10.)

Trophosome.—Colony about 7 inches high, irregularly branched. Stem and branches fascicled. Hydrocladia alternate, often without distinct internodes, but with small internal thickenings just below the supracalycine nematophores and opposite the lower part of the hydrothecæ. Hydrothecæ deep, anterior outline concave, margin with 3 lateral teeth on each side and a rather longer anterior tooth. Supracalycine nematophore slender, terete, distinctly overtopping the hydrotheca; mesial nematophore short, not reaching the middle of the hydrotheca, regularly convex in outline.

Gonosome.—Gonangia borne on modified hydrocladia which do not form pseudo-corbulæ, but which are irregularly interspersed among normal hydrocladia. Each of these modified hydrocladia has a normal hydrotheca at its base, then one or more aborted hydrothecæ, then globular gonangia arising regularly from aborted hydrothecæ, each with a mesial and 2 supracalycine nematophores. Gonangia flattened, containing blastostyles supporting gonophores which are partly encircled by a sickle-shaped rim of cœnosarc.

Locality.—Station 4000, southwest of the island of Molokai, 213 fathoms.

This species is particularly interesting for two reasons. First, its gonosome furnishes a beautiful example of the homology between the gonophore and the hydranth, the former arising from aborted hydrothecæ. Second, we have in this species a further proof, if any more is needed, of the fact that a classification of the genera of the Plumularidæ can not be based on the trophosome alone, for the trophosome of this form is almost a typical *Aglaophenia*, while its gonosome is that of a true *Cladocarpus*.

Genus HALICORNARIA.

Trophosome.—Stem not fascicled. Hydrothecæ with no posterior intrathecal ridge. Hydrocladia not branched and without septal ridges.

Gonosome.—Gonangia borne on the stem or on the bases of the hydrocladia, not taking the place of hydrothecæ, and not protected by corbulæ or protective branches of any kind.

Halicornaria flava Nutting, new species.

(Pl. VI, fig. 2; pl. XIII, figs. 11, 12.)

Trophosome.—Colony attaining a height of about 5 inches. Brownish yellow in color. Stem monosiphonic, not regularly branched, divided into regular internodes, each of which bears a hydrocladium. Hydrocladia alternate; nodes not seen in profile, but marked by translucent lines when viewed by reflected light. Hydrothecæ orbicular, large, margin with a single broad lateral lobe on each side, and one in front and another behind; a very strong anterior intrathecal ridge arising from above the middle of the hydrotheca and ending in a round knob at its center. Mesial nematophore attached throughout to the front of the hydrotheca and ending in a point projecting above the margin of the latter; the nematophore having a strong chitinous point at about its middle, projecting inward toward the hydrotheca, a unique feature in this genus so far as I know. Supracalycine nematophores short, triangular, not reaching nearly to the top of the hydrotheca. There are 2 strong, broad cauline nematophores at the front of the base of each hydrocladium.

Gonosome.—Gonangia in the form of simple pyriform bodies arranged in a row along the front of the stem, one at the base of each hydrocladium. Their tops do not seem to have regular apertures of any kind, but simply to be ruptured by the escape of the sexual elements. There are no protective branchlets.

Locality.—Station 3939, north of the island of Laysan, 163 fathoms.

The bright brownish-yellow color of this species is quite conspicuous when the specimens are fresh.

Halicornaria bryani Nutting, new species.

(Pl. VI, fig. 4; pl. XIII, figs. 13, 14.)

Trophosome.—Colony parasitic on *Lytocarpus similis*, attaining a height of about 3 inches. Stem simple, divided into regular internodes, each of which bears a hydrocladium. Hydrocladia stout, not evidently divided into internodes. Hydrothecæ very large, ovate in outline, margin with 1 or 2 ill-defined lateral sinuations; intrathecal ridge anterior, very strong, ending in a round knob. Supra-calycine nematophore small, not reaching to margin of the hydrotheca; mesial nematophore very short and strong, variable in shape, with a regularly arched outline and ending considerably below the hydrothecal margin.

Gonosome.—Gonangia obconoid, with truncate summits, borne in a row on the front of the stem, each being at the base of a hydrocladium. No phylactogonia. The hydrothecæ of this species are the largest that I have seen in the genus.

Locality.—Station 4000, southwest of the island of Kauai, 213 fathoms.

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EXPLANATION OF PLATES.[a]

PLATE I.

Hydrodendrium gorgonoides Nutting.

Fig. 1. Part of colony (× 5).
2. Cross section of stem, showing naked cœnosarc above (× 125).
3. Hydranth and gonophore (× 25).
4. Cross section of stem, showing irregular lacunæ (× 25).
5. Longitudinal section of hydranth (to the right), and gonophore (to the left), showing ova in the endoderm (× 125).
6. Longitudinal section of male gonophore, showing spermary (× 125).

PLATE II.

(All figures × 5.)

Fig. 1. Corydendrium minor Nutting.
2. Corydendrium corrugatum Nutting.
3. Balea mirabilis Nutting.
4. Campanularia eloisa Nutting.
5. Halecium scandens Nutting.
6. Campanularia eloisa Nutting.

PLATE III.

(All figures × 5.)

Fig. 1. Stegopoma gilberti Nutting.
2. Stegopoma gracilis Nutting, growing as a parasite on Halicornaria.
3. Stegopoma plumicola Nutting, parasitic on Lytocarpus phoeniceus.
4. ?Cryptolaria operculata Nutting.
5. ?Opercularella longicauda Nutting.
6. Lafoea contorta Nutting. Basal part of colony to the left, distal part to the right.

[a] The photomicrographs were made by the author. The pen drawings were made by Mrs. Elizabeth B. Darrow, after camera lucida drawings in pencil by the author.

PLATE IV.

(All figures × 5.)

Fig. 1. Lictorella cervicornis Nutting, showing gonosome.
2. Cryptolaria symmetrica Nutting.
3. Sertularella crenulata Nutting.
4. Sertularella torreyi Nutting.
5. Sertularia snyderi Nutting.
6. Diphasia palmata Nutting.

PLATE V.

(Figures 3–6 × 5. Figs. 1 and 2 are much more highly magnified than the others.)

Fig. 1. Plumularia milleri Nutting, showing peculiar disposition of the gonangia.
2. Plumularia delicata Nutting.
3. Monostæchas fisheri Nutting.
4. Antennella complexa Nutting.
5. Thecocarpus niger Nutting, showing gonosome.
6. Lytocarpus hawaiensis Nutting, showing gonosome.

PLATE VI.

(All figures × 5.)

Fig. 1. Lytocarpus balei Nutting.
2. Halicornaria flava Nutting.
3. Lytocarpus similis Nutting.
4. Halicornaria bryani Nutting.
5. Plumularia jordani Nutting.

PLATE VII.

Fig. 1. Hydrodendrium gorgonoides Nutting, single hydranth with hernia-like gonophore.
2. Expanded hydranth.
3. Balea mirabilis Nutting, part of branch.
4. Balea mirabilis, single hydranth, showing the two whorls of tentacles.
5. Corydendrium corrugatum Nutting, part of branch.
6. Corydendrium corrugatum, single hydranth and hydrophore.
7. Oral view of hydranth.
8. Corydendrium minor Nutting, part of branch.
9. Corydendrium minor, sessile medusa.

PLATE VIII.

Fig. 1. Halecium scandens Nutting, part of branch.
2. Halecium scandens, hydranth and hydrophore.
3. Halecium scandens, gonangium and gonophore.
4. Campanularia eloisa Nutting, part of colony with gonangium.
5. Campanularia eloisa, hydrotheca.
6. Campanularia eloisa, hydrotheca.
7. Campanularia eloisa, part of branch showing scattered pedicels.
8. Stegapoma gracilis Nutting, group of hydrothecæ.
9. Stegopoma gracilis, hydrotheca and gonangium.

PLATE IX.

Fig. 1. Stegopoma gilberti Nutting, part of colony.
2. Stegopoma plumicola Nutting, group of hydrothecæ.
3. Stegopoma plumicola, hydrotheca and gonangium.
4. Opercularella longicauda Nutting, group of hydrothecæ.
Figs. 5, 6. Opercularella longicauda, hydrothecæ showing different positions of the opercula.
7. Opercularella longicauda, gonangium.
8. Lafœa contorta Nutting, group of hydrothecæ on main stem.
9. Lafœa contorta, hydrothecæ on end of branch.

PLATE X.

Fig. 1. Lictorella halecioides (Allman), cross section of part of "coppinia" mass.
2–4. Lictorella halecioides, gonangia.
5. Lictorella cervicornis Nutting, part of branch.
6. Lictorella cervicornis, hydrotheca (much enlarged).
7. Lictorella cervicornis, nematophore (greatly enlarged).
8. Lictorella cervicornis, group of gonangia with phylactogonia.
9. Litorella cervicornis, single gonangium with phylactogonium.
10. Cryptolaria symmetrica Nutting, proximal part of branch.
11. Cryptolaria symmetrica, distal part of branch.
12. Cryptolaria operculata Nutting, part of a branch.
13, 14. Cryptolaria operculata, single hydrothecæ.
15. Sertularia snyderi Nutting, part of colony.

PLATE XI.

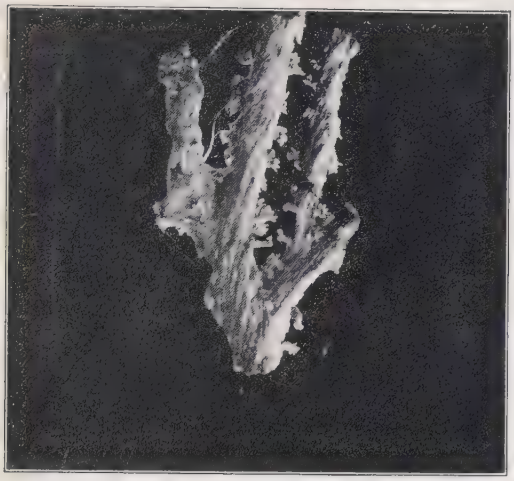
Fig. 1. Sertularella dentifera Torrey, gonangium.
2. Sertularella torreyi Nutting, part of stem with gonangium.
3. Sertularella torreyi, end of branch.
4. Sertularella crenulata Nutting, part of branch.
5. Sertularella crenulata, hydrotheca (much enlarged).
6. Sertularella crenulata, gonangium.
7. Sertularella crenulata, end of gonangium showing aperture.
8. Diphasia palmata Nutting, part of stem.
9 and 10. Diphasia palmata, front and lateral views of gonangia.

PLATE XII.

Fig. 1. Plumularia jordani Nutting, part of a colony.
2. Plumularia jordani, hydrotheca and nematophores (greatly enlarged).
3. Plumularia delicata Nutting, part of branch.
4. Plumularia delicata, hydrothecate internode (much enlarged).
5. Plumularia delicata, gonangium.
6. Plumularia milleri Nutting, part of colony with gonangia.
7. Plumularia milleri, hydranth.
8. Monostæchas fisheri Nutting, part of branch.
9. Antennella complexa Nutting, part of branch.
10. Lytocarpus hawaiensis Nutting, part of stem showing branch origin and nematophores.
11. Lytocarpus hawaiensis, hydrothecæ.
12. Lytocarpus hawaiensis, gonangium with phylactogonium.
13. Lytocarpus hawaiensis, side view of gonangium.

PLATE XIII.

Fig. 1. Thecocarpus niger Nutting, three hydrothecæ.
2. Thecocarpus niger, one hydrotheca (greatly enlarged).
3. Thecocarpus niger, part of stem, showing nematophores and hydrocladial origin.
4. Thecocarpus niger, corbula.
5. Thecocarpus niger, section of corbula, showing gonangium.
6. Thecocarpus niger, corbula leaf with basal hydrotheca.
7. Lytocarpus balei Nutting, three hydrothecæ.
8. Lytocarpus balei, branchlet with gonangia.
9. Lytocarpus similis Nutting, three hydrothecæ.
10. Lytocarpus similis, gonangia on branchlet.
11. Halicornaria flava Nutting, three hydrothecæ.
12. Halicornaria flava, gonangium.
13. Halicornaria bryani Nutting, three hydrothecæ.
14. Halicornaria bryani, gonangium.



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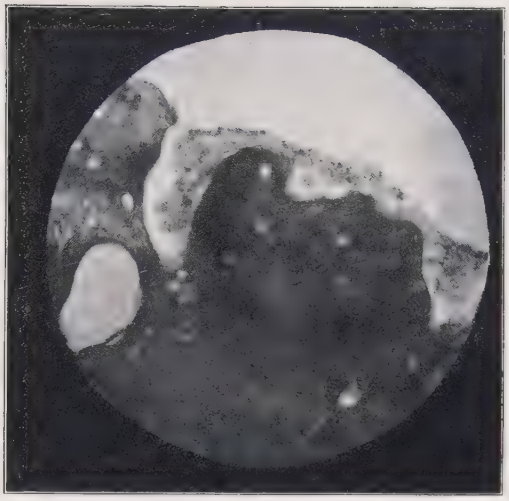

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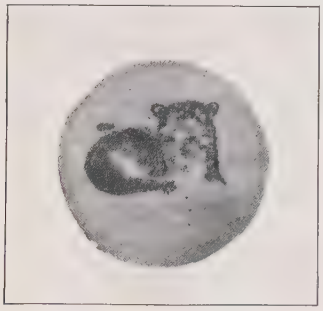

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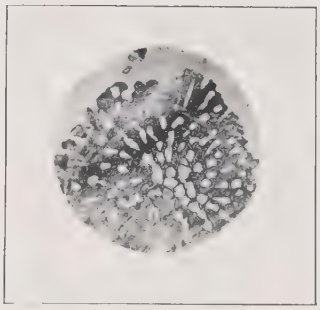

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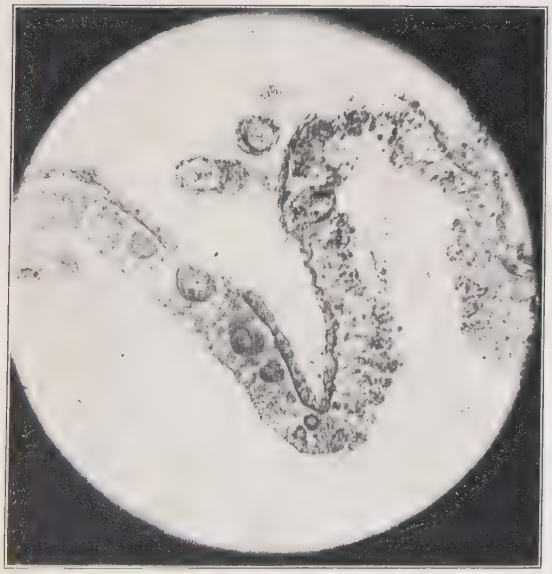

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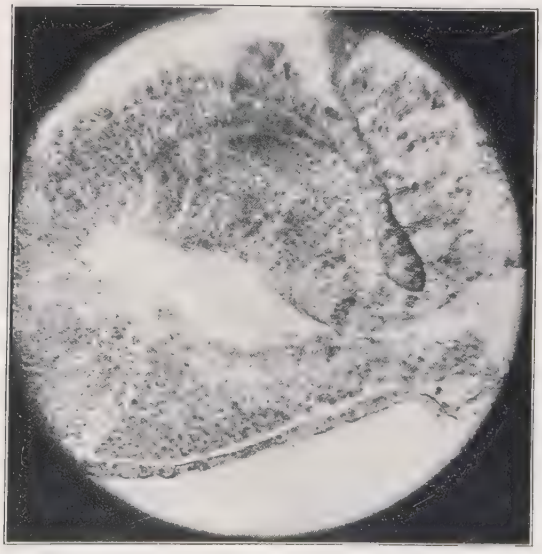

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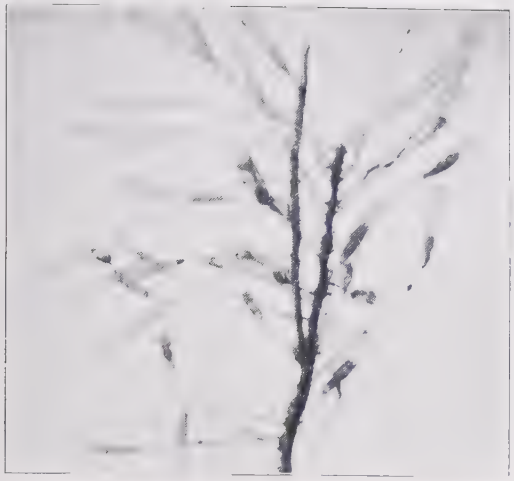

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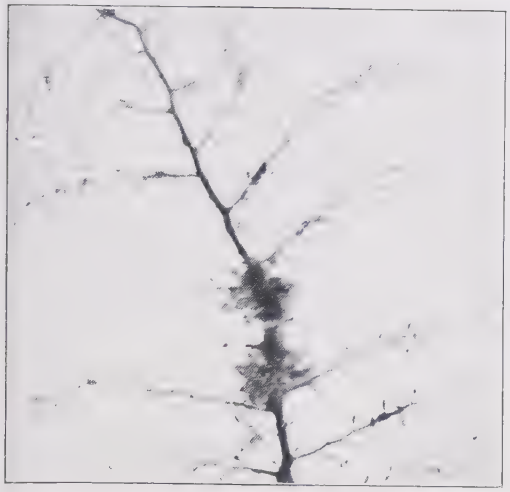

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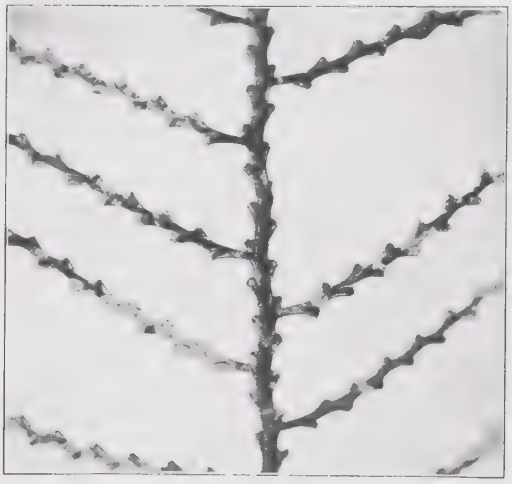

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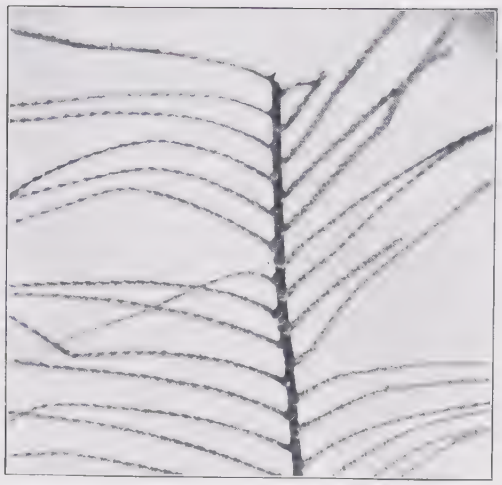

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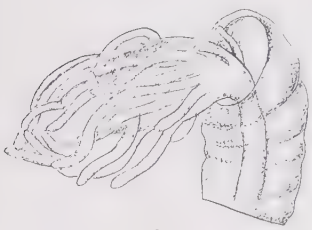

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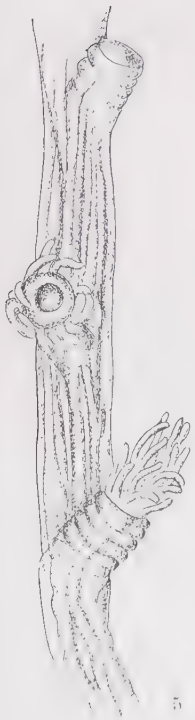

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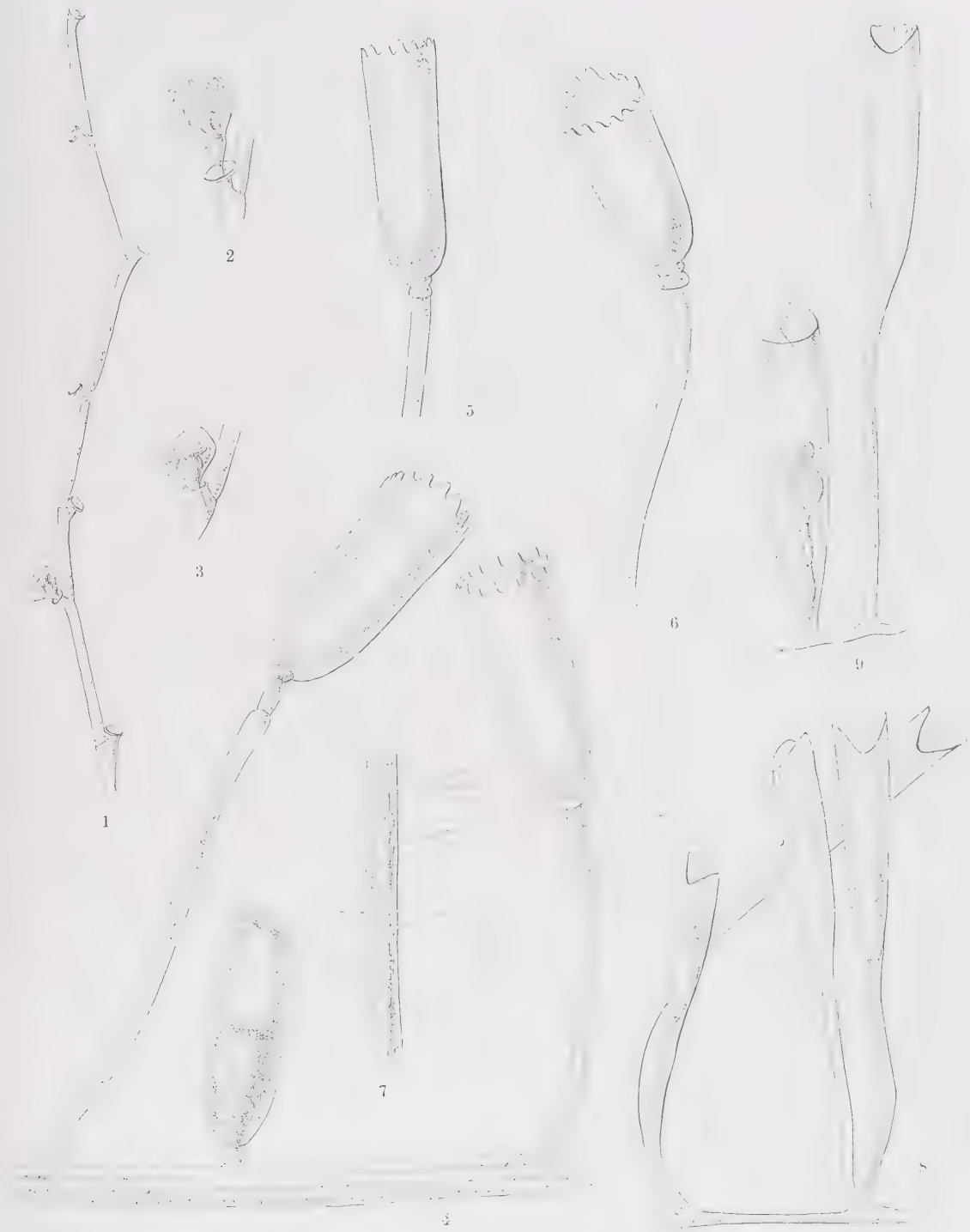
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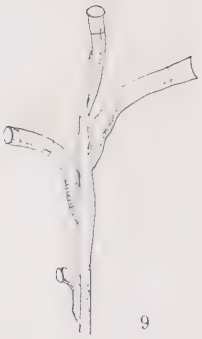

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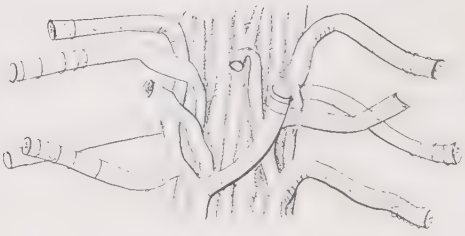

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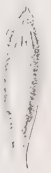

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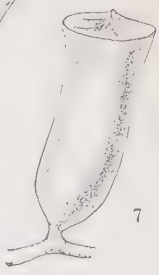

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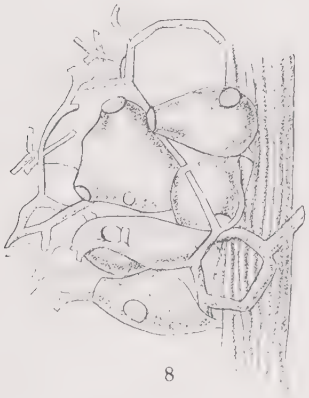

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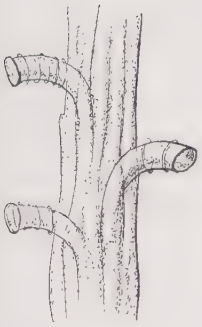

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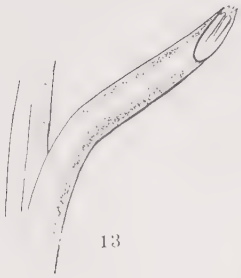

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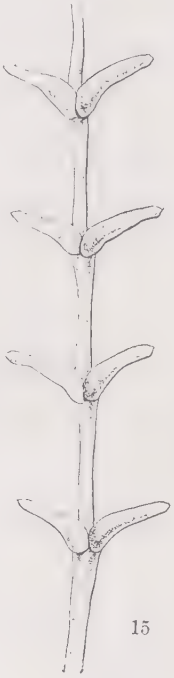

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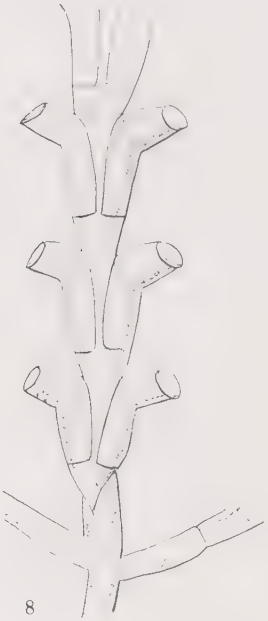

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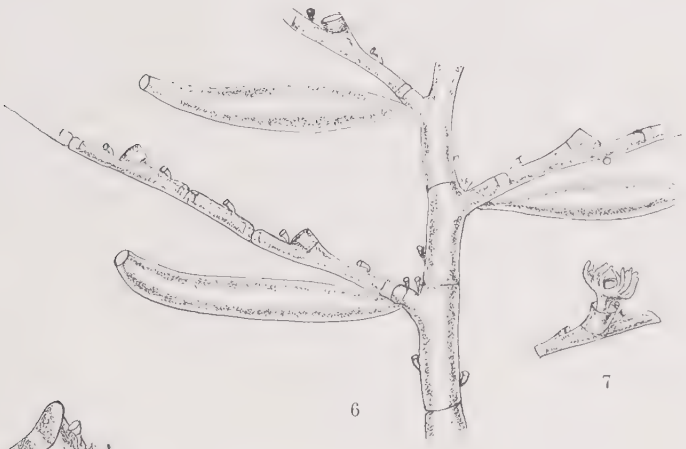

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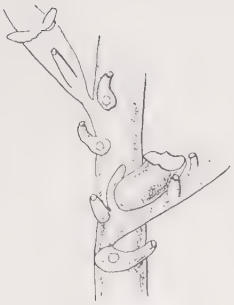

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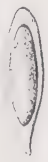

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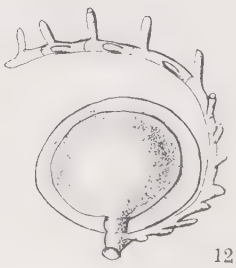

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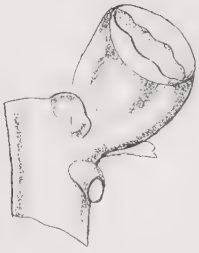

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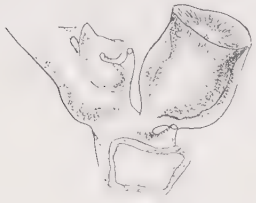

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SCHIZOPODS OF THE HAWAIIAN ISLANDS COLLECTED BY THE STEAMER ALBATROSS IN 1902.

By A. E. ORTMANN,
Curator of Invertebrate Zoology, Carnegie Museum, Pittsburg, Pa.

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SCHIZOPODS OF THE HAWAIIAN ISLANDS COLLECTED BY THE ALBATROSS IN 1902.

By A. E. ORTMANN,
Curator of Invertebrate Zoology, Carnegie Museum, Pittsburg, Pa.

In the present collection there are represented 21 recognizable species, none of which are new, although one might be regarded as a new variety. Six species are already known from this region, 5 of which are distinctly pelagic forms, although the two species of *Stylocheiron* seem to prefer a certain depth. These 5 are: *Euphausia bidentata*, which was captured by the *Albatross* on a previous trip between San Francisco and the Hawaiian Islands; *Stylocheiron carinatum*, which is known from the "North Pacific" (*Challenger*, without exact locality); *Stylocheiron abbreviatum*, which was captured by the *Challenger* north of the Hawaiian Islands; *Siriella thompsoni*, which is known from the "North Pacific" (*Challenger*) and from between San Francisco and the Hawaiian Islands (*Albatross*); and *Siriella gracilis*, which has been reported from the Northern Pacific by Streets and the *Challenger*. The sixth species previously known from this region is *Boreomysis obtusata*, which was found by the *Challenger* north of the Hawaiian Islands. This seems to be a deep-sea form.

The other 15 species in this collection have not been found previously near the Hawaiian Islands. For some of them this new locality is not remarkable, since they have been found in other parts of the Pacific Ocean; but other cases are more or less interesting on account of the great distance of the localities from which they have been previously recorded. The discovery in the Pacific of the two pelagic forms, *Euphausia pseudogibba* and *Stylocheiron longicorne*, which were known hitherto only from the Atlantic Ocean, is in keeping with what is known of the distribution of related forms, and the same may be said of *Nematodactylus boöpis*, which up to the present time was known only from Ireland. In two instances, however, *Lophogaster* and *Anchialus*, a very close examination of the material at hand was necessary to remove all doubt as to the actual identity of the species in question, since the known facts of distribution rather led to the expectation that the Hawaiian forms would prove to be distinct.

Further detail concerning the geographical distribution of the single species will be given below at the proper places.

SYSTEMATIC ACCOUNT OF THE SPECIES.

Order EUPHAUSIACEA Boas.

Family EUPHAUSIIDÆ Dana.

Genus THYSANOPODA Milne-Edwards.

1. Thysanopoda obtusifrons G. O. Sars.

Thysanopoda obtusifrons G. O. Sars, Rep. Voy. *Challenger*, 13, 102, pl. 18, figs. 1–14, 1885; Alcock & Anderson, Journ. Asiat. Soc. Bengal, 1894, 63, 3.

A careful comparison of the present material with Sars's description has led to the conviction that these specimens agree better with this species than those collected by the Plankton Expedition in the Atlantic, and described by the present writer under this name.[a] The only difference from Sars's account I am able to discover is that the preanal spine in most of our specimens is present and simple; it was seen in 14 of them, while 3 did not show it (the remaining 1 was dissected before it was examined in this respect). Sars calls this spine "obsolete," but we must bear in mind that he had only 3 individuals at his disposal.

Further, the lobe of the first joint of the antennula is different in shape from that given in Sars's figure (fig. 2 on pl. 18); its inner portion, projecting over the base of the second joint, is drawn as square (with rounded angles), while in our specimens (I have made, however, only one slide) it is rather triangular, the inner angle being produced.

For the rest, our specimens agree completely with *T. obtusifrons*, and we are to mention especially that there is no lateral denticle on the carapace, and that the serrate keels of the telson correspond closely to Sars's description and figure (fig. 3, pl. 18). In these respects and in size (our largest is 19 mm. long; Sars gives 23 mm.) they differ from the specimens taken by the Plankton Expedition and specimens recorded under this name from the Mediterranean.[b] This Atlantic species has recently been called *T. vulgaris* by Hansen.[c]

Stations: 3806, 50 fathoms, 23° 25′ 36″ N., 152° 24′ 30″ W., Erben Bank to Kaiwi Channel, 5 specimens; 3888, 50 fathoms, 22° 10′ N., 155° 35′ 45″ W., northeast of Kaiwi Channel, 13 specimens.

Distribution.—"Pacific" and "South Pacific" are the localities given for the specimens collected by the *Challenger*. Alcock and Anderson mention it from the Laccadive Sea, Indian Ocean, 1,250 fathoms.

2. Thysanopoda agassizi Ortmann.

Thysanopoda agassizi Ortmann, Bull. Mus. Harvard, 14, 1894, 99.

The individual at hand is much larger than the specimens previously recorded. The largest from the Panama region measures 19 mm., while the present one is 32 mm.; but it agrees completely with the description, except that the preanal spine is well developed and has two points, one shorter than the other.

Color in life, according to label: "Light vermilion, darkest on thoracic feet."

Station: 3804, 50 fathoms, 24° 58′ 42″ N., 149° 11′ W., between Erben Bank and Kaiwi Channel, 1 specimen.

Distribution.—Gulf of Panama, 200 fathoms, and between Galapagos and Acapulco, 0–200 fathoms (Ortmann).

Genus EUPHAUSIA Dana.

3. Euphausia bidentata (G. O. Sars).

Euphausia pellucida G. O. Sars, Rep. Voy. *Challenger*, 13, 1885, 75, pl. 11 and 12; Ortmann, Decap. & Schizop. Plankton Exped., 11, 1893; Ortmann, Bull. Mus. Harvard, 25, 1894, 101. Caullery, Ann. Univ. Lyon, fasc. 2, 1896, 367. Holt & Tattersall, Rept. Fish. Ireland, 2 app., 4, 1905, 101 and 133.

[a] Ortmann, Decapoden und Schizopoden Plankton Exped., 1893, p. 10.

[b] Salv. lo Bianco, Pelagische Tiefseefischerei der "Maja," p. 35, pl. 14, fig. 48, 1904. Capri, Naples, about 1,000 m.

[c] Hansen, Bull. Mus. Oceanogr. Monaco, No. 30, 1905, p. 15.

Euphausia bidentata Stebbing, Pr. Zool. Soc. London, 1900, 544.
Euphausia pellucida S. lo Bianco, Pelag. Tiefseefisch. Maja, 37, pl. 16, fig. 50, 1904.

I follow Stebbing (1900) in using the name of *E. bidentata* Sars for this species, without being fully convinced that *E. pellucida* of Dana is a different form. I readily concede, however, that *E. pellucida* (as well as *E. muelleri* Claus) is at least doubtful, which is sufficient reason for discarding this name.

Stations: 3797, surface, 31° 55′ N., 135° W., East Pacific, 4 specimens; 3797, 25 feet below surface, 31° 55′ N., 135° W., East Pacific, 2 specimens; 3829, surface, south coast of Molokai Island, 1 specimen; 3867, surface, Pailolo Channel, 16 specimens; 3901, surface, Pailolo Channel, 24 specimens; 3912, surface, south coast of Oahu Island, 1 specimen; 3926, surface, 21° 20′ N., 158° 43′ W., southwest of Oahu, 5 specimens; 3929, surface, 23° 19′ N., 166° 54′ W., between Honolulu and Laysan, 2 specimens; 3980, surface, 21° 23′ N., 158° 19′ W., between Honolulu and Kauai, 1 specimen; 4009, surface, 21° 50′ 30″ N., 159° 15′ W., southeast of Kauai, numerous specimens; 4011, surface, 21° 20′ N., 158° 21′ W., between Kauai and Oahu, 1 specimen; 4145, surface, 22° 27′ 30″ N., 160° 40′ W., between Kauai and Modu Manu, 9 specimens.

Distribution.—Almost cosmopolitan; reported from the Arctic and Northern Atlantic (as far north as 60° N.), subtropical and tropical Atlantic, South Atlantic, South and Central Pacific, Indian Ocean. (See Ortmann, 1893.)

In addition to the localities listed by Ortmann in 1893, we have to record numerous localities off the west coast of America: Panama, Galapagos, off California, and between California and the Hawaiian Islands (Ortmann, 1894). Vertical distribution, surface to about 900 meters. Caullery (1896) reports this species from 1,710 meters in the Gulf of Biscay. Lo Bianco (1904) says that at Capri the young are found near the surface, while the adult forms prefer depths of over 500 meters.

4. **Euphausia pseudogibba** Ortmann.

Euphausia pseudogibba Ortmann, Decap. & Schizop. Plankton Exped., 12, pl. 1, fig. 6, 1893. Stebbing, Pr. Zool. Soc., London, 1900, 545. Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 11.

The specimens agree completely with this form. The preanal spine has been described as 1 to 4 pointed (rarely 1-pointed). Among 9 individuals of the present material (station 3867), 4 have it 1-pointed and 4 have it 2-pointed (in the ninth it is damaged). In the specimen from station 3799, which is larger than any of the others, it is 3-pointed.

Stations: 3799, 100 fathoms, 29° 22′ N., 139° 31′ W., East Pacific, 1 specimen; 3867, surface, Pailolo Channel, 10 specimens.

Distribution.—This is the first record of this species outside of the Atlantic Ocean. On account of the similarity to *E. gibboides*, this is important. *E. pseudogibba* has been found hitherto only by the Plankton Expedition and the *Princess Alice* in the Atlantic: Sargasso Sea, North Equatorial, Guinea, and South Equatorial currents, between surface and 650 meters, but not *at* the surface.

Genus NEMATOSCELIS.

Material belonging to this genus and to the one following has been obtained at various stations situated between California and the Hawaiian Islands, namely, 3799, 100 fathoms; 3801, 100 fathoms; 3802, 150 fathoms; 3803, 50 fathoms; 3805, 50 fathoms; 3807, 50 fathoms.

This material generally is in a very poor condition. In the first line the legs are missing, and, further, the eyes are largely destroyed; both organs are absolutely necessary for the proper identification of genus and species. The latter fact, the destruction of the eyes, is very remarkable, and has been noticed before in these genera by the writer. In my opinion, it is due to the hauling up of the specimens from a certain depth, as indicated by the present records, 50 to 150 fathoms. Apparently the change of pressure causes this deformation of the eyes, which is best described as a bursting. Although the specimens have been largely rendered useless for systematic purposes, the condition in which they are tends to confirm their actual existence at the recorded depths.

Genus STYLOCHEIRON G. O. Sars.

In a few specimens belonging to *Stylocheiron* the elongated legs are preserved, and thus the writer was enabled to identify them. They are the following:

5. Stylocheiron carinatum G. O. Sars.

Stylocheiron carinatum G. O. Sars, Rep. Voy. *Challenger*, 13, 137, pl. 26, 1885. Ortmann, Decap. & Schizop. Plankton Exped., p. 17, 1893.

Only two specimens are fairly well preserved, but they unquestionably belong here.

Station 3801, 100 fathoms, 28° 31′ N., 141° 47′ W., between Erben Bank and Kaiwi Channel 2 specimens.

Distribution.—This species has been found by the *Challenger* in the North Pacific; in the Central Pacific (off Kandavu, Fidji); off Mindanao, Philippines, and in the South Atlantic. The Plankton Expedition obtained it in the Sargasso Sea and the South Equatorial Current; it has also been recorded from the Brazil Current (Ortmann). Vertical distribution, 0–200 fathoms.

6. Stylocheiron suhmi G. O. Sars.

Stylocheiron suhmi and *longicorne* G. O. Sars, Rep. Voy. *Challenger*, 13, 142, 144, pl. 27, f. 1–5, 1885. Ortmann, Decap. & Schizop. Plankton Exped., 13, 1893.

Stylocheiron suhmi Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 30.

Stylocheiron longicorne Holt & Tattersall, Rept. Fish. Ireland, 2 app., 4, 1905, 109, 140.

Our specimen is much damaged; head and carapace are separated from the rest of the body, but the second true leg is preserved, and this agrees with that of *S. longicorne;* also the eyes and other characters seem to indicate that we have to deal with this species.

Station 3803, 50 fathoms, 25° 39′ 45″ N., 147° 41′ 45″ W., 1 specimen.

Distribution.—This species was found by the *Challenger* south of the Cape of Good Hope and in the Pacific (New Guinea and Philippines), and Sars mentions it from Messina, Mediterranean Sea. The Plankton Expedition and the *Princess Alice* found it widely distributed in the Atlantic: Gulf Stream, Sargasso Sea, North and South Equatorial, and Guinea Currents.

7. Stylocheiron abbreviatum G. O. Sars.

Stylocheiron abbreviatum G. O. Sars, Rep. Voy. *Challenger*, 13, p. 147, pl. 27, f. 11–13, 1885. Ortmann, Decap. & Schizop. Plankton Exped., p. 17, 1893; Bull. Mus. Harvard, 25, 1894, p. 104. Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 31.

Stylocheiron chelifer Chun, Bibl. Zool., 7, 1896, 167, pl. 11; Holt & Tattersall, op. cit., p. 110, 141.

The present specimen is about 14 mm. long, and thus much larger than that of Sars (8 mm.); but it agrees well with the latter except that the second pair of true legs is comparatively longer and stronger, which, however, is easily accounted for by the age.

Station 3805, 50 fathoms, 24° 08′ 15″ N., 150° 51′ W., 1 specimen.

Distribution.—The *Challenger* took this species in the Pacific, north of the Hawaiian Islands, in the tropical and northern Atlantic. The Plankton Expedition found it widely distributed in the tropical and subtropical Atlantic to a depth of 1,500 meters. The *Albatross* had taken it previously off Galera Point in the Panama region of the Eastern Pacific.

Genus NEMATOBRACHION Calman.

8. Nematobrachion boöpis (Calman).

Nematodactylus boöpis Calman, Trans. Roy. Irish Acad., 31, 1896, 17, pl. 2, f. 19–28. Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 29.

Nematobrachion boöpis Calman, Rept. Fish. Ireland, 2 app., 4, 1905, 153, pl. 26.

The present specimen is in poor condition (broken in two), but the legs are well preserved. These, as well as the shape of the carapace and the eyes, of antennæ and antennulæ, agree well with Calman's description. Especially the very characteristic, greatly elongated, second true leg is abso-

lutely identical with Calman's account and figure (fig. 26). Also the general shape of the abdomen corresponds to that of this species; the telson is damaged. A more minute investigation of the other characters (chiefly those of generic value) was not advisable, since only one individual is at hand, and this in very poor state of preservation. The only difference noticed is that the antennal scale is slightly longer than in Calman's species, reaching to the middle of the third joint of the peduncle.

Station: 4005, 577–480 fathoms, vicinity of Kauai Island, 1 specimen.

Distribution.—Found so far only at the southwest coast of Ireland in 1,020 fathoms, and Bay of Biscay, 237–1,000 fathoms (Calman), and subtropical Atlantic between Gibraltar, Azores, and Canary Islands (Hansen).

Order MYSIDACEA Boas.

Family LOPHOGASTRIDÆ G. O. Sars.

Genus LOPHOGASTER M. Sars.

9. Lophogaster typicus M. Sars.

Lophogaster typicus M. Sars, in Forh. Skand. Naturf. Moede Christiania, 1856, 160. M. Sars, in Christiania Univ. Progr., 1862, 1, pl. 1–3. G. O. Sars, Rep. Voy. *Challenger*, 13, 14, pl. 1, f. 1–7, 1885. Norman, in Ann. Nat. Hist. (6) 9, 459, 1892. Caullery, in Ann. Univ. Lyon, fasc. 2, 1896, 367. Walker, in Trans. Liverpool Biol. Soc. 12, 1898, 164. Holt & Beaumont, in Trans. Roy. Dublin Soc. (2) 7, part 7, 1900, 3. Thompson, Catal. Crust. & Pycnog. Mus. Dundee, 23, 1901. Lo Bianco, Pelag. Tiefseefisch. Maja, 33, pl. 12, f. 44, 1904.

Ctenomysis alata Norman, in Rep. Brit. Assoc., 1861, 151.

The discovery of a *Lophogaster* at the Hawaiian Islands made necessary a close investigation of its relation to the known form of the Atlantic. The abundant material at hand rendered this a comparatively easy task, and it was found that the present form agrees very closely with the descriptions furnished by M. and G. O. Sars for the Norwegian and the Cape forms. Only a few remarks seem necessary.

(1) The rostral spine is generally in our material a little longer than in the typical form, but there is considerable variation in this respect, as has already been pointed out by G. O. Sars. In a few of the present specimens, the rostrum does not differ from the typical shape, but in most cases it is slightly longer, although falling short of the end of the peduncle of the antennules. Sometimes, however, it reaches the end of the latter, and even surpasses it, as is most distinctly the case in the large female from station 3965.

(2) In most of our specimens, there is only 1 small lateral denticle on either margin of the telson while there are 3 in the typical form. In fact, I found only 1 denticle in all the younger specimens examined (I examined a large number from station 4101, although not all of them); in the large female from station 3965, however, there are 3 denticles, as usual.

(3) Most of our specimens do not seem to be fully adult; those of stations 3847, 3858 and 4101 hardly surpass 20 mm. (one of 3858 is 22 mm.), and generally the males are a little larger than the females, as has been stated by Sars for the typical form. The male from station 3857 is 24 mm. long, and the female from 3965 is 28 mm. This latter, consequently, exceeds all measurements previously given. Nevertheless, the much smaller females from station 4101 seem to be adult—at least, are able to propagate, since the marsupium is full in some of them.

(4) The lateral wings of the carapace are produced posteriorly into a point, which is more or less distinctly spiniform, most distinctly so in the large female from station 3965.

(5) The outer margin of the antennal scale has 3 to 5 teeth, a variation already noticed by Sars. I have found that this number may even differ on the right and left side of the same individual.

None of the above aberrations justify the creation of a new species, not even of a variety. Although there is a tendency in the Hawaiian form to develop a longer rostrum and to reduce the number of the marginal denticles of the telson, this furnishes no constant characters, the normal conditions being found at least in some specimens.

Stations: 3847, 23 to 24 fathoms, south coast of Molokai, 2 males; 3857, 127 to 128 fathoms, Pailolo Channel, 1 male; 3858, 128 to 138 fathoms, Pailolo Channel, 9 males; 3884, 284 to 290 fathoms, Pailolo Channel, 1 male; 3965, 147 to 116 fathoms, vicinity of Laysan Island, 1 female; 4101, 143 to 122 fathoms, Pailolo Channel, numerous specimens, male and female, males much more abundant,

Distribution.—Coast of Norway, Shetland Isles, west and southwest coast of Ireland, 20–100 fathoms (Sars, Norman, Walker, Holt & Beaumont). Bay of Biscay, 35–60 fathoms (Norman), 400 meters (Caullery). Mediterranean: Messina (Norman), Toulon, 445 meters, Naples, 500 meters and more (Bianco); south of Cape of Good Hope, 98–150 fathoms (G. O. Sars).

According to previous records, this species would seem to be bipolar, but the present localities in the region of the Hawaiian Islands completely overthrow this assumption, hinted at by G. O. Sars. This form is also found in the tropical belt, and there in about the same depth as in the European waters and at the Cape. The extremes recorded for our specimens are 23 and 290 fathoms. We are to expect that this species will be discovered elsewhere in the circumtropical regions as well as in other parts of the seas, and very likely it will finally prove to be cosmopolitan at the proper depth.

Genus GNATHOPHAUSIA Willemoes-Suhm.

10. Gnathophausia gigas Willemoes-Suhm.

Gnathophausia gigas, G. O. Sars, Rep. Voy. *Challenger*, 13, 33, pl. 3, 1885.

Our specimen differs from the description given by Sars in the following points: The infero-posterior spines of the carapace are a little longer; the posterior dorsal spine is well developed, resembling in size and shape that of *G. calcarata*; the branchiostegal spine is much stronger than in Sars' specimen, and decidedly longer than either the antennal or the supraocular spines. The outer edge of the antennal scale has 4 teeth, of which the posterior is very small. The rostrum (which was broken in Sars' specimen) is very long—longer than indicated in Sars' figure; the part in front of the supraocular spines is exactly as long as the carapace between supraocular spines and base of the posterior dorsal spine. The color of our specimen is preserved and is a delicate crimson.

The differences in development of the postero-dorsal, infero-posterior, and branchiostegal spines are not so important, in my opinion, as to indicate that this form differs specifically from *G. gigas*. I rather believe that the differences are due to age, since among other material at hand (see *G. longispina*) just the parts named exhibit corresponding variations in specimens of different age. Our specimen is 50 mm. long, while that of Sars was 142 mm.

Among a collection of schizopods from Alaska which have been sent by the U. S. National Museum to the writer for identification, and which will be described elsewhere, there has been found a specimen of this species closely corresponding to the Hawaiian specimen. It is slightly larger than the latter (55 mm.), but the branchiostegal spine is even more developed, and the supraorbital spines are distinctly larger than the antennal spines. The outer margin of the antennal scale has 5 distinct teeth in this individual.

Station 4144, 850–767 fathoms, vicinity of Kauai Island, 1 male young.

Distribution.—Captured by the *Challenger* at station 69, west of the Azores, in 2,200 fathoms. Sars thinks that the "recently molted skin of the outer part of the tail of another specimen" brought up by the *Challenger* from 1,950 fathoms in the Antarctic Ocean, between Kerguelen and Australia (station 157), also belongs here; but I see no possibility of identifying this species from so meager remains, and it would be better to strike off this latter locality from the records until it is confirmed.

The present locality at the Hawaiian Islands extends enormously the range of this species, and suggests the cosmopolitan character of its distribution. As has been mentioned above, it is also present amongst material from Alaska.

11. Gnathophausia calcarata G. O. Sars.

Gnathophausia calcarata G. O. Sars, Rep. Voy. *Challenger*, 13, 35 pl., 4, 1885.

The measurements of our specimens are as follows: Station 4109, total length, 37 mm., of which 15 mm. belong to the rostrum (in front of the supraocular spines); station 4142, total length, 43 mm., of which 14 mm. belong to the rostrum. The measurements given by Sars for his two specimens are 68 and 98, respectively. Our specimens, consequently, are young, and they agree best with the smaller individual described by Sars, the carapace of which is figured on Sars's plate 4, figure 3. The postero-dorsal, the infero-posterior, and the branchiostegal spines are very strongly developed, even stronger than in the figure quoted, and they are a little more divergent, while antennal and

supraocular spines agree well with Sars's account. The only difference is in the antennal scale, which, although similar to Sars's figure, has the oblique truncation of the apex hardly noticeable; it is more like fig. 2 on Sars's plate than like the figs. 4 and 5. The scale is generally narrower, with three serrations on the outer margin, the first one quite remote from the spiniform tip, but not separated from it by an emargination.

G. bengalensis Wood-Mason (Ann. Nat. Hist. (6) 8, 1891, p. 269), from the Bay of Bengal, 1,748 fathoms, is said to be near *G. calcarata*, but to differ, among other points, in the postero-inferior and other spines, which are almost smooth, in the antennal scale, which is more emarginate, and in the epimeral lappets of the last abdominal segment.

Stations: 4109, 442–449 fathoms, Kaiwi Channel, 1 male; 4142, 632–881 fathoms, vicinity of Kauai Island, 1 male.

Distribution.—This species was taken by the *Challenger* in the Arafura Sea, 800 fathoms, and at the Philippines (near Talaur Island, south of Mindanao), 500 fathoms.

12. Gnathophausia willemoesi G. O. Sars.

Gnathophausia willemoesi G. O. Sars, Rep. Voy. *Challenger*, 13, 38 pl., 5 f. 1–6, 1885. Faxon, Mem. Mus. Harvard, 18, 1895, 215.

Our male has the total length of 52 mm., of which 12 mm. belong to the rostrum. The female is 73 mm. long, of which 13 mm. belong to the rostrum; the latter, however, is damaged at the tip. The larger of the two specimens examined by Sars was 136 mm. long. Our specimens agree completely with Sars's account of this species.

Stations: 3887, 552–809 fathoms, north coast of Molokai, 1 male; 4038, 689–670 fathoms, west coast of Hawaii, 1 female.

Distribution.—Banda Sea, 1,425 fathoms (Sars). Panama region: Gulf of Panama, 1,270 fathoms; off Acapulco, Mexico, 493 and 664 fathoms; Tres Marias Islands, 680 fathoms. (Faxon.)

13. Gnathophausia sarsi Wood-Mason.

Gnathophausia sarsi Wood-Mason, Ann. Nat. Hist. (6) 7, 1891, 187.

Our specimens correspond completely to Wood-Mason's description of this species, with the exception of the last sentence, which says: "The telson * * * appears to be more produced at the tip than in any other species." No such peculiarity in the shape of the telson is apparent in our specimen.

The individual from station 4166 is 62 mm. long, of which 16 mm. belong to the rostrum (in front of the supraocular spines), but the rostrum is damaged at the tip. The specimens from station 4005 are all smaller than this one, the smallest possessing a total length of 34 mm. Wood-Mason gives 75 mm. from tip of the rostrum to end of telson.

The label of the set from station 4005 gives the color as "scarlet vermilion;" in the specimen from station 4166 the color is still preserved, and is of a brilliant scarlet. All our specimens seem to be males, since in none of them are incubatory lamellæ visible.

Stations: 4005, 577–480 fathoms, vicinity of Kauai Island, 4 males; 4166, 293–800 fathoms, vicinity of Modu Manu or Bird Island, 1 male.

Distribution.—Bay of Bengal, 16° 55′ 41″ N., 83° 21′ 18″ E., 840 fathoms (Wood-Mason).

The above localities extend considerably the range of this species.

14. Gnathophausia longispina G. O. Sars.

Gnathophausia longispina G. O. Sars, Rep. Voy. *Challenger*, 13, 46 pl., 7 f., 1–5, 1885.

An examination of the rich material of this species collected by the *Albatross* shows that there is quite a variability in the development of the different spines of the carapace. The length of the rostrum and dorsal spine varies considerably; generally they are comparatively longer in young specimens. The branchiostegal spines in older specimens are not quite so strong and are directed obliquely forward, and the outer spine of the antennal scale is not so excessively developed.

The following table of measurements gives an idea of the relative dimensions of rostrum, carapace, and posterior dorsal spine.

Sex.	Station.	Total length.	Length of rostrum.[a]	Length of carapace.[b]	Length of dorsal spine.	Dorsal spine reaches to abdominal segment.
		mm.	*mm.*	*mm.*	*mm.*	
Male	3909	29	11	5	5	Beginning of fifth.
Do	4105	51	17	13	8	Middle of fourth.
Do	4105	52	16	14	7	End of third.
Female	3908	54	16	14	7	Middle of third.
Male	4105	57	14	16	6	End of second.
Female	4106	62	16	17	7	Middle of third.

[a] In front of the supraocular spines.

[b] Excluding rostrum and dor al spine.

Comparing this table with the characters given by Sars we observe the following:

"Rostrum almost twice the length of the carapace." In very young specimens it is over twice the length, in large ones it is comparatively shorter, in the largest the rostrum is even absolutely shorter than the carapace.

"Dorsal spine projecting to about the end of the fourth (abdominal) segment." In larger specimens it does not project so far, in the smallest it projects a little farther.

Generally speaking, we may say that with advancing age the different spines and the rostrum become comparatively shorter; that is to say, they retain about the absolute size they had in medium-sized specimens, while the rest of the body grows. Thus only our small and medium-sized specimens correspond more or less exactly to Sars's description. Sars's largest specimen (out of five) was 59 mm. long.

The specimens from station 3824 are labeled "Carmine vermilion."

Stations: 3467, 310 fathoms, 1 female; 3471, 337 fathoms, 6 males, 3 females; 3473, 313 fathoms, 1 female; 3474, 375 fathoms, 5 males; 3475, 351 fathoms, 2 males, 1 female; all from the southeast coast of Oahu. 3824, 222–498 fathoms, 1 female, and 3826, 430–371 fathoms, 2 males, 1 female; from the south coast of Molokai. 3907, 315–304 fathoms, 2 males; 3908, 304–308 fathoms, 1 female; 3909, 308–322 fathoms, 6 males; 3911, 337–334 fathoms, 1 male; 3925, 323–299 fathoms, 3 males; all from the south coast of Oahu. 4105, 314–335 fathoms, 3 males; 4106, 335–350 fathoms, 1 male; 4107, 350–355 fathoms, 1 male; all from Kaiwi Channel.

Distribution.—Captured by the *Challenger*, off Samboangan, Philippines, 250 fathoms.

Family EUCOPIIDAE G. O. Sars.[a]

Genus EUCOPIA Dana.

15. Eucopia australis Dana.

Eucopia australis Dana, U. S. Expl. Exp. Crust. 1, p. 609, pl. 11, f. 10, 1852. G. O. Sars, Rep. Voy. *Challenger*, 13, 55, pl. 9 and 10, 1885. Wood-Mason, in Ann. Nat. Hist. (6) 8, 1891, 270. Faxon, Mem. Mus. Harvard, 18, 1895, 218. Calman, Trans. Roy. Irish Acad. 31, 1896, 15. Thompson, Catal. Crust. Pycnog. Mus. Dundee, 23, 1901. Holt & Tattersall, Rept. Fish. Ireland, 2, 1905; App. 4, 142. Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 5.

Chalaraspis unguiculata Willemoes-Suhm, in Trans. Linn. Soc. London (2) 1, 1873, p. 37, pl. 8.

The present specimen is in a very poor state of preservation, but the shape of the eyes, of the frontal margin, of the telson, and of the 3 anterior pairs of legs are recognizable, and agree well with Sars's account of this species. It is apparently a male, no marsupial lamellæ being seen.

Station: 3887, 552–809 fathoms, north coast of Molokai Island, 1 male.

Distribution.—Apparently cosmopolitan, in depths to about 2,000 fathoms (350 to 2,500 fathoms in the Atlantic according to Willemoes-Suhm). The species must go up into shallower water occasionally, however, since it has been taken out of the stomach of a penguin (Dana).

Special localities are the following: North Atlantic: Southwest coast of Ireland, 1,020 fathoms (Calman); south of Nova Scotia, 1,250 fathoms (Sars); west of Azores, 1,000 fathoms (Sars). Tropical

[a] This family, no doubt, is very closely allied to the *Lophogastridæ*, and is not separated from them by some authors The very peculiar differentiation of the legs, however, is in favor of the retention of Sars's family.

Atlantic: North of Cape Verde Islands, 1,975 fathoms (Sars); midway between Africa and Brazil, 1,500 fathoms (Sars). Antarctic Ocean: 66° 12′ S., 149° 44′ E. (Dana); between Cape of Good Hope and Kerguelen, 1,375 fathoms (Sars); south of Australia, 1,800 fathoms (Sars). Indian Ocean: Bay of Bengal, 561 fathoms, and Gulf of Manaar, 738 fathoms (Wood-Mason). Tropical Pacific: Off Peru, 0–1,770 fathoms; Galapagos, 551 fathoms; Gulf of Panama, 764 fathoms; Gulf of California, 0–700 and 1,218 fathoms (Faxon). North Pacific: Off Japan, 1,875 fathoms (Sars); Bering Sea, 660 fathoms (Thompson).

16. Eucopia sculpticauda Faxon.

Eucopia sculpticauda Faxon, Bull. Mus. Harvard, 24, 1893, 218. Faxon, Mem. Mus. Harvard, 18, 219, pl. K, f. 2, pl. 53 f. 1, 1895. Hansen, Bull. Mus. Ocean. Monaco, 30, 1905, 7, fig. 4.

With the female from station 4005 were the following notes about color:

"The carapace is very deep, velvety, port-wine red or "purple," so intense as to appear almost black in poor light, extending caudad along dorsum of abdomen, shading off to deep carmine on rest of abdomen, including swimmerets and telson, which is a trifle lighter. Appendages of head and thorax: Long legs, madder carmine; short appendages, deep port-wine red; antenna, madder pink; exopodite, bright carmine; antennule, bright carmine."

Stations: 4005, 577–480 fathoms, 1 female, and 4144, 850–767 fathoms, 1 male, from vicinity of Kauai Island.

Distribution.—Gulf of Panama, 1,000 fathoms, and Galapagos Islands, 885 and 1,360 fathoms; subtropical Atlantic, between Gibraltar, Azores, and Canary Islands, between surface and 3,000 meters (Hansen).

Family MYSIDAE Dana.

Genus PETALOPHTHALMUS Willemoes-Suhm.

17. Petalophthalmus pacificus Faxon.

Petalophthalmus pacificus Faxon, Bull. Mus. Harvard, 24, 1893, 218. Faxon, Mem. Mus. Harvard, 18, 1895, 223, pl. 54.

Our specimen agrees absolutely with Faxon's species.

Station 4157, 762–1,000 fathoms, vicinity of Modu Manu, 1 male.

Distribution.—Gulf of California, 0–700 fathoms.

Genus BOREOMYSIS G. O. Sars.

18. Boreomysis obtusata G. O. Sars.

Boreomysis obtusata G. O. Sars, Rep. Voy. *Challenger*, 13, 182, pl. 33, f. 1–6, 1885.

Although not well preserved, the specimens agree clearly with this species. Sars says that the eyes have a dark reddish pigment; in our specimens the eyes are pale brown, which possibly is due to the action of the alcohol. The female from station 4014 has lost both eyes.

Stations: 4014, 399–362 fathoms, 1 male, 1 female; and 4018, 804–724 fathoms, 1 male; both from vicinity of Kauai Island.

Distribution.—Off coast of Japan, 35° 11′ N., 139° 28′ E., 345 fathoms, and north of Hawaiian Islands, 37° 52′ N., 160° 17′ W., 2,740 fathoms.

Genus SIRIELLA Dana.[a]

19. Siriella thompsoni (Milne-Edwards).

Siriella thompsoni, G. O. Sars, Rep. Voy. *Challenger*, 13, 205, pl. 36, f. 1–24, 1885. Ortmann, Decap. & Schizop. Plankton Exped., 23, 1893; Bull. Mus. Harvard, 25, 1894, 107.

The specimens (females) from station 3799 were marked: "Hyacinth blue eggs, body translucent."

Stations: 3797, surface, Erben Bank to Kaiwi Channel, 31° 55′ N., 136° W., 12 males, 8 females;

[a] Norman (Ann. Nat. Hist. (6) 10, 1892, p. 149) abandoned *Siriella* Dana in favor of *Cynthilia* Gray, June 15, 1850, but later (ibid., p. 263) restored it, *Siriella* having been published by Dana in the early part of 1850. This latter correction has been overlooked by Ehrenbaum (Beitr. Meeres. Helgoland 8, 1897, p. 424).

3799, surface, Erben Bank to Kaiwi Chann., 29° 22′ N., 139° 31′ W., 2 females; 3801, 100 fathoms, Erben Bank to Kaiwi Chann., 28° 31′ N., 141° 47′ W., 2 males, 1 female; 3802, 150 fathoms, Erben Bank to Kaiwi Chann., 27° 04′ 15″ N., 144° 18′ 30″ W., 1 male; 3829, surface, south coast of Molokai, 1 female; 3867, surface, Pailolo Channel, 2 males, 5 females; 3889, surface, north coast of Molokai, 2 males; 3912, surface, south coast of Oahu, 1 male, 2 females; 3926, surface, between Honolulu and Laysan, 21° 13′ N., 158° 43′ W., 2 males; 3927, surface, between Honolulu and Laysan, 21° 31′ N., 161° 55′ W., 6 males, 8 females; 3929, surface, between Honolulu and Laysan, 23° 19′ N., 166° 54′ W., 3 males; 3930, surface, between Honolulu and Laysan, 25° 07′ N., 170° 50′ W., 6 males, 1 female; 3980, surface, between Honolulu and Kauai, 21° 33′ N., 158° 19′ W., 1 male; 4011, surface, between Kauai and Oahu, 21° 20′ N., 158° 21′ W., 1 male, 1 female; 4086, surface, northeast coast of Maui, 1 male, 2 females; 4145, surface, between Kauai and Modu Manu, 22° 27′ 30″ N., 160° 40′ W., about 100 males, 30 females.

Distribution.—North, Tropical, and South Atlantic; North and South Pacific; Australian seas; Indian Ocean; apparently generally distributed in the tropical and subtropical parts of all oceans, on the surface. Our stations 3801 and 3802 are remarkable, because they record this species from the depth of 100 and 150 fathoms (two open intermediate tow nets, set tandem).

20. Siriella gracilis Dana.

Siriella gracilis, Streets, Bull. U. S. Nat. Mus. I, 1877, No. 7, 123; G. O. Sars, Rep. Voy. *Challenger*, 13, 209, pl. 36, f. 25–28, 1885. Ortmann, Bull. Mus. Harvard, 25, 1894, 107. Thompson, Catal. Crust. Pycnog. Mus. Dundee, 24, 1901.

It is interesting to note that at station 4009 a large number of this species was captured, without *Siriella thompsoni*, with which it was found associated at the other stations.

Stations.—3867, surface, Pailolo Channel, 4 males; 4009, surface, between Kauai and Oahu, 21° 50′ 30″ N., 159° 15′ W., about 35 specimens, male, female, and young; 4086, surface, northeast coast of Maui, 2 males, 2 females; 4145, surface, between Kauai and Modu Manu, 22° 27′ 30″ N., 16° 40′ W., 13 males.

Distribution.—Pacific (Dana); West, North, and Tropical Pacific (Sars); North Pacific, 20°–30° N., 145°–149° W. (Streets); near Galapagos Islands and between Galapagos and Acapulco (Ortmann); Bay of Bengal (Thompson). Surface.

This species seems to be restricted to the tropical and subtropical parts of the Indian and Pacific Oceans. It has not been recorded from the Atlantic Ocean.

Genus ANCHIALUS Kröyer.

21. Anchialus typicus Kröyer.

Anchialus typicus, G. O. Sars, Rep. Voy. *Challenger*, 13, 193 pl. 34 f. 4–27, 1885.

The very remarkable new localities at which our material was secured have made necessary a very careful comparison with Sars's descriptions and figures (all parts are figured by Sars, except the first maxilla), and I am unable to discover any differences from the characters given by him (p. 193) as "specific," with the exception that he says that the apical incision of the telson occupies "one seventh of the length" of the telson, while in our specimens it occupies between one-fifth and one-sixth. This, however, is clearly due to a mistake on the part of Sars on page 193, since on page 196 he says that the incision occupies "about one-fifth" of the length, the correctness of which is further substantiated by the figure of the telson (pl. 34, fig. 26).

Going carefully over Sars's "description" of this species, I discovered only the following points which deviate in our specimens:

(1) The male gnathopod has, according to Sars, a strong triangular expansion on the inner edge of the carpal joint, which, according to the figure (pl. 34, fig. 17), is almost spiniform. In my slides this expansion is present, but less spiniform.

(2) I can not discover in my slides the peculiar structure of the outer branch of the fourth pair of male pleopods, described by Sars, and figured in figs. 24 and 25 on pl. 34. In my slides this branch is "somewhat more produced," but has no peculiarities in the shape of the joints and arrangment of natatory setae.

(3) The palp of the mandibles is more elongate in my specimens; the first joint is less wide, comparatively, and the second is much longer than represented in Sars's fig. 12; it is not ovate, but rather linear.

(4) The first true leg of the male (Sars's fig. 18) has the propodite only slightly dilated, and consists apparently of one single joint (Sars draws three of them), followed by a very small terminal one, which is hidden by peculiarly developed, long spines; the latter are less numerous than in Sars's figure, and less distinctly fasciculate.

I am not prepared to say whether these differences might constitute specific or varietal characters. If they should prove to be of taxonomic value, we ought to create, for this form, a new species or variety, for which I should like to propose the name *Anchialus hawaiiensis*.

Stations.—3812, surface, south coast of Oahu, 2 males; 3829, surface, south of Molokai, close to Lanai Island, numerous specimens, all males; 3921, surface, off Honolulu, numerous specimens, male and female, females prevailing.

Distribution.—Tropical Atlantic, 14° N. (Kröyer); off Cape of Good Hope, surface; 34° 41′ S., 18° 36′ E. (Sars).

The present localities extend the known range of this species considerably. Sars believes that the species of the genus *Anchialus* are pelagic surface forms, and in this case the wide distribution would correspond to that of many other pelagic creatures. That they are captured rarely may be due to the fact that they seem to be nocturnal; at least at the three localities at which our material was taken the hauls were made at night (7.30 to 8.45 p. m.), with the aid of electric light, during the night anchorage of the *Albatross*. In two of our hauls this species was represented by a very large number of individuals, while not a single other haul in this region contains a trace of it. I think we have here the original home of this species, which is to be sought in shallow water near the shore, but it hides somewhere during the daytime, and appears as a planktonic form at night, possibly only during a certain season.

NEMERTEANS OF THE HAWAIIAN ISLANDS COLLECTED BY THE STEAMER ALBATROSS IN 1902.

By WESLEY R. COE,

Assistant Professor of Comparative Anatomy, Sheffield Scientific School, Yale University.

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Among the collections made by Prof. C. H. Gilbert and party with the U. S. Fish Commission steamer *Albatross* at the Hawaiian Islands in the summer of 1902 are a number of well-preserved specimens of nemerteans. These specimens, however, represent only three species, of which two are believed to have been undescribed hitherto. Microscopic study reveals a number of interesting anatomical peculiarities, which are detailed below. Two of the species belong to the genus *Tæniosoma*, which is abundantly represented in nearly all tropical and subtropical regions. The third belongs to the genus *Drepanophorus*, but is unfortunately represented by the proboscis only, so that its specific identity is indeterminable.

All the specimens were obtained by the dredge at depths of from 21 to 282 fathoms.

The fact that so few nemerteans were collected by the *Albatross* party must not be taken as an indication that more extended shore collecting would not yield a much larger number of species. Comparatively few miscellaneous collections of invertebrates contain numerous species of this group, even from localities where such worms are abundant. So far as is known to the writer no nemerteans whatever have previously been recorded from the Hawaiian Islands or from the deep water in their vicinity. On this account the present collection, although very meager, possesses a certain interest. Its principal value, however, is due to the interesting anatomical peculiarities revealed in the new species it contains.

TÆNIOSOMA Stimpson.

Tæniosoma Stimpson, Proc. Ac. Nat. Sci. Phila., 1857, 162.
Polia Delle Chiaje, Mem. sulla storia e notomia degli animali senza vertebre del regno di Napoli, Naples, 1823–28.
Eupolia Hubrecht, Report of Challenger Exped., Zoöl., XIX, 1887.
Eupolia Bürger, Fauna u. Flora von Neapel, Monogr. 22, p. 598, 1895.
Tæniosoma Coe, Proc. Washington Ac. Sci., III, 1901, 61.

This genus is widely distributed in tropical and subtropical waters, and its presence at the Hawaiian Islands was to have been expected. As has been stated elsewhere[a], Stimpson's name for it

[a] Coe, Proc. Wash. Ac. Sci., III, 1901, 4.

has indisputable priority over the name *Eupolia*, although the latter is still retained by most European writers. The fact that Stimpson in 1857[a], in establishing his new genus *Tæniosoma*, in addition to giving a satisfactory generic diagnosis, specially mentioned *Borlasia quinquelineata* Quoy & Gaimard as a typical species of the genus leaves no valid excuse for ignoring this name and adopting that given by Hubrecht thirty years later. Furthermore, Stimpson in the same paper describes as new species two forms, *T. septemlineatum* and *T æquale* (=*T. quinquelineatum*) both of which are typical representatives of the genus. Although Stimpson's generic diagnosis is brief it is accurate, and its brevity is justified by the citation of a well-known typical species.

The species belonging to this genus show a remarkable specific variation in the general shape and size of the body. Some are characterized by extremely long, slender, flattened, and much-twisted bodies, while others are short, thick, and cylindrical. In nearly all the species, however, the head in life is rounded in front and is sharply marked off from the parts immediately following by lateral constrictions. Horizontal furrows are wanting, but small, oblique or transverse grooves are usually present on the head. In strong contraction the posterior portion of the head becomes greatly swollen and the snout is withdrawn into it, the anterior end of the body becoming large and abruptly truncated.

Proboscis sheath and proboscis short, seldom reaching more than one-third the length of body. Proboscis opening subterminal, minute. Mouth situated on the ventral surface immediately behind the ganglia.

Muscular layers of body composed of a thick outer longitudinal, a circular, and a less thickened inner longitudinal layer. Outside the muscular layers is a well developed cutis, composed of a thick inner layer of connective tissue, and an outer layer of glandular tissue. External epithelium thin as compared with the other layers of the body, though the basement layer separating it from the cutis is usually well developed. Musculature of proboscis consists of an inner longitudinal and an outer circular muscular layer; consequently muscular crosses are wanting. Cephalic glands enormously developed, stretching backward on all sides beyond the brain, and often reaching some distance into the esophageal region.

Lateral nerves situated immediately outside circular muscular layer. Ocelli usually present in great numbers, though very small. There are three longitudinal blood vessels.

These worms are sluggish in their habits, are unable to swim, and usually show great irregularities in the diameter of the body. They often twist their bodies in sharp coils or in knots, or lie tangled together in lumps. All species are extremely contractile.

Tæniosoma univittatum sp. nov.

(Pl. 1, figs. 1–3; text cuts 1, 2.)

This species is represented in the collection by four well-preserved specimens which were dredged from depths between 127 and 178 fathoms.

The specimens bear a close external resemblance to those of a species which Isler,[b] in 1900, described from the Indian Ocean (Ceylon) under the name *Eupolia unistriata*. The next year, and evidently written while Isler's paper was in press, Punnett[c] gave a description of a very similar species, also collected in the Indian Ocean (Maldive Islands), to which he gave a name identical with that which Isler gave to his species, viz, *Eupolia unistriata*. Isler's specimens were yellowish-white with a narrow longitudinal stripe of olive green, while Punnett's specimens were white with a similar narrow stripe of black. Those described by Isler possessed numerous ocelli; Punnett does not state in his description whether such sense organs were present in his specimens, but he writes me that they are as well developed as in *T. melanogrammum*. The two forms, to which the one specific name was given by both of these investigators, are evidently very closely related, if not identical. Although very similar to them in form and coloration of body, the species herein described, *Tæniosoma univittatum*, differs in the total absence of ocelli and in minor anatomical details.

From *Tæniosoma hemprichi* (Ehrenberg) and *T. mediolineatum* (Bürger), both of which possess a median ventral as well as a median dorsal brown or blackish stripe, the present species differs conspicuously in the possession of a dorsal stripe only.

[a] Proc. Ac. Nat. Sci. Phila., 1857, 162.

[b] Zool. Anzeiger, XXIII, 1900, p. 178.

[c] Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelagoes, Vol. 1, p. 106, pl. IV, fig. 4, 1901.

As in *Tæniosoma unistriatum*, the present species is conspicuously marked, having a whitish or very pale-colored body, with a sharply marked dorsal line of reddish brown or black color extending the whole length of the body (pl. 1, figs. 1, 2).

After preservation, the body is of moderate proportions, rounded throughout, largest in esophageal region a short distance behind mouth; head rounded in front, marked off from body by fairly distinct transverse lateral grooves which, when the head is contracted, form an annular constriction immediately in front of mouth; anterior portion of head, or snout, demarcated from the posterior portions. When strongly contracted the head is much swollen and the snout partially withdrawn into the posterior part of it (pl. 1, fig. 2). Mouth and proboscis pore situated as in related species.

Careful examination of the specimens after clearing in cedar oil and in microscopic sections failed to reveal the presence of any ocelli. Their absence is doubtless correlated with the depth at which these worms live. Three other species of the genus, *T. australe*, *T. girardii*, and *T. nipponense*, are described by Hubrecht[a] from the Challenger collections as having been dredged from depths of 300 fathoms or more. Whether ocelli are likewise wanting in these species is not mentioned, although nearly all the other known species of the genus possess them. Mr. R. C. Punnett, however, informs me that he has recently collected an eyeless species in Norway.

Size.—Length of each of two specimens which were not strongly contracted, 50 to 60 mm.; width, 1.5 to 2 mm. Two contracted specimens were each 20 to 30 mm. long and 3 mm. in diameter in anterior portion of esophageal region.

Color.—After preservation for a short time, the whole body is creamy white with the exception of a single sharply-marked stripe of reddish brown extending in the dorsal median line throughout the whole length of the body. These colors probably represent very closely the natural coloration in life.

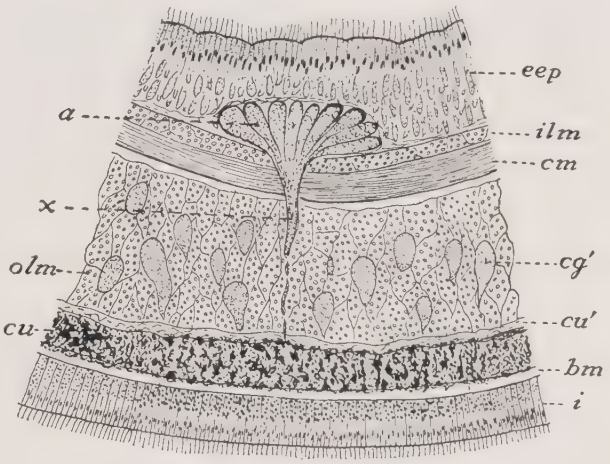


FIG. 1.—*Tæniosoma univittatum* sp. nov. Portion of transverse section of body in anterior portion of esophageal region, showing peculiar multicellular gland (*a*) situated internal to the body walls and immediately outside the esophageal epithelium (*eep*); (*x*) Duct of gland; (*ilm*) Internal longitudinal muscles; (*cm*) Circular muscles; (*olm*) Outer longitudinal muscles; (*cu*) Glandular layer of cutis; (*cu'*) Fibrous layer of cutis; (*bm*) Basement layer; (*i*) Integument. × 90.

In the two specimens which are fairly well extended (pl. 1, fig. 1) the dorsal stripe is a narrow line of less than 0.3 mm. in width, but is sharply marked and conspicuous throughout because of its very dark color. In the two specimens which are strongly contracted (pl. 1, fig. 2) the stripe is about 1 mm. in width anteriorly and 0.5 mm. wide farther back. In the extended specimens the stripe is only one-eighth as wide as the body, while in the contracted specimens it is from one-third to one-fourth the width of the body.

On the dorsal side of the head the stripe becomes narrower (pl. 1, fig. 3) and terminates immediately above the proboscis pore or very near the exact end of the dorsal surface of the snout. It is also narrower in the posterior half of the body, but extends nearly or quite to the posterior extremity.

The stripe remains of a reddish brown color after preservation for a few months in alcohol, but at the end of a year is hardly to be distinguished.

Proboscis well developed for the genus; attached to the tissues of the head immediately anterior to the ventral brain commissure; composed of the usual muscular, nervous, and epithelial layers.

Body walls.—The comparative thickness of the various layers which constitute the body walls is shown in text cuts 1 and 2. Integument rather high; basement layer thin; cutis in esophageal region from two-thirds to three-fourths as thick as integument, its glandular layer being about twice as thick as the underlying connective tissue layer (fig. 1).

[a] Challenger Reports, XIX, p. —, 1887.

Cephalic glands enormously developed, occupying the whole thickness of the outer longitudinal muscular layer in the mouth and anterior esophageal regions, and making up fully three-fourths the substance of this layer. A short distance back of the mouth these glands begin to decrease in abundance in the dorsal half of the body, and gradually disappear, except for scattered clusters in the midst of the outer longitudinal muscular layer in the ventral half of the body (fig. 1, *cg'*). They disappear completely at about four-fifths the distance from mouth to anterior end of stomach.

In the single specimen sectioned a very peculiar gland (fig. 1, *a*) is present in the anterior portion of the esophageal region. It is situated in the mid-ventral line of the body, directly beneath the esophageal epithelium, and thus quite internal to the body walls. A large and conspicuous duct (fig. 1, *x*) filled with secretion passes through the body walls to the superficial integument, thus discharging the secretion from the gland on the mid-ventral surface of the body. The gland itself is composed of some 20 or more large clusters of gland cells, each cluster resembling one of the groups of

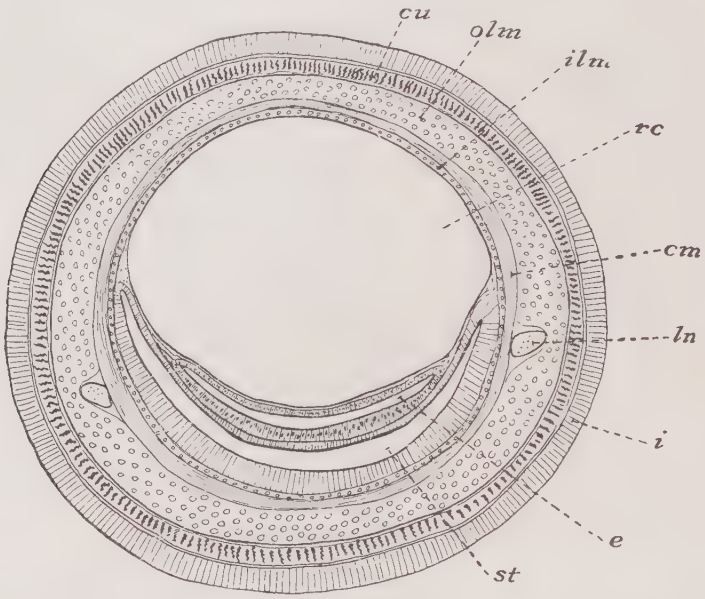


FIG. 2.—*Tæniosoma univittatum* sp. nov. Transverse section through posterior end of esophageal region, showing section of esophagus (*e*) immediately anterior to its opening into dorsal wall of stomach, a short blind portion of which (*st*) lies ventral to posterior end of esophagus; (*rc*) rhynchocœl; (*ln*) lateral nerve. Other reference letters as in fig. 1. × 30.

the cephalic glands (fig. 1, *cg'*) which lie in the midst of the outer longitudinal muscular layer in the same region. The duct through which the secretion is discharged is, like the ducts from the cephalic glands, merely temporary, and exists only when filled with secretion.

It is doubtful whether this gland occurs in all individuals of the species. It seems more probable that it is an abnormally developed cluster of cephalic glands which has pierced the underlying circular and inner longitudinal muscular layers, and has come to lie quite internal to the body walls.

Alimentary canal.—Mouth and esophagus as in related species. At about midway between mouth and intestine proper the esophagus opens into the stomach, from which it is sharply demarcated both anatomically and histologically. In the single specimen sectioned the esophagus did not open directly into the anterior end of the stomach, but into the dorsal wall of the latter at some little distance from its anterior end. Thus a blind anterior pouch of the stomach (fig. 2, *st*) lies beneath the posterior end of the esophagus (*e*), and recalls the intestinal cæcum of the Hoplonemertea. As commonly occurs in the Heteronemertea, the esophagus is much flattened dorso-ventrally, and is crescentic in cross section. The epithelium of the ventral wall is several times as thick as that of the dorsal wall (fig. 2). The esophagus is somewhat diminished in size at its posterior end, although its opening into the dorsal wall of the stomach is quite large.

The walls of the stomach are without lobes except near its posterior end, where lateral pouches make their appearance. The most anterior of these pouches are but little developed, but they gradually become deeper at the approach to the intestine proper. The histological structures, too, gradually assume the characteristics peculiar to the intestine, so that there is no sharp line of demarcation between stomach and intestine proper. Similar conditions have been described for a number of Heteronemerteans.

Nephridia.—The nephridial tubules are small and inconspicuous. They are situated, as in most related species, on the lateral borders of the posterior portion of the esophagus and beside the anterior portion of the stomach. There are numerous efferent ducts of minute size which pass immediately dorsal to the lateral nerves and open on the dorso-lateral surface of the body. About 8 efferent ducts could be distinguished on each side, although there may have been more, for their exact number was difficult to determine in the specimen sectioned because some of the ducts were so very inconspicuous as to be hardly distinguished from radial bundles of connective tissue fibers which pass at irregular intervals through the body walls, particularly in the vicinity of the lateral nerves.

Blood vascular system.—This presents few deviations from the arrangement of vessels found in related species. The cephalic lacunæ, however, are smaller than in most other forms of the genus.

Nervous system as in related species. Cerebral sense organs remarkably voluminous, with a large glandular lobe situated ventrally to the main body of each of the sense organs.

Reproductive organs.—Sexual products immature in a specimen collected in April.

Habitat.—Of the four specimens of this species collected by the *Albatross*, two were dredged at station 3855, south coast of Molokai, at a depth of 127 to 130 fathoms. The bottom here was composed of fine brown sand and gravel; bottom temperature, 65.5° F. The other two came from station 4079, north coast of Maui Island; depth, 143 to 178 fathoms; bottom composed of gray sand and foraminifera; bottom temperature, 60.8° F.

The species may therefore be looked upon as inhabiting depths of over 100 fathoms, and this fact will partially account for the absence of eyes.

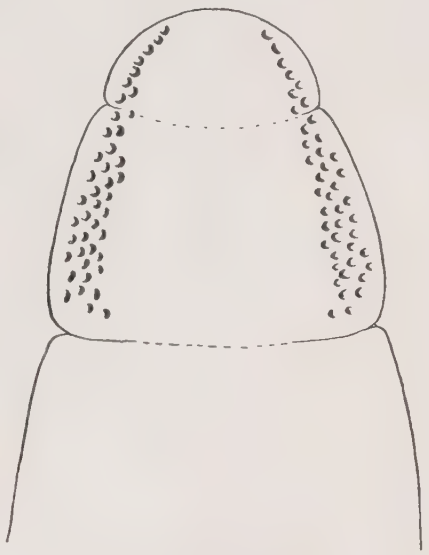


FIG. 3.—*Tæniosoma cingulatum* sp. nov. Outline of anterior portion of body of preserved specimen, showing position and arrangement of ocelli, the transverse groove separating snout from remaining portions of head, and the similar groove separating head from esophageal region. × 23.

Tæniosoma cingulatum sp. nov.

(Pl. 1, figs. 4–6; text cuts 3–7.)

Body long and slender, rounded throughout (pl. 1, fig. 4); head rather slender, with a distinct annular groove situated immediately in front of mouth and separating head from succeeding portions of the body; a less distinct groove lies farther forward on the head and marks off the snout from the posterior portion of the head (fig. 3; pl. 1, fig. 6). Esophageal region somewhat wider than intestinal region, into which it passes without external line of demarcation.

Size.—Length of two preserved specimens (pl. 1, figs. 4, 5), 90 and 250 mm.; width, 3 mm. in esophageal region and 2 mm. in more posterior portions of the body. The two specimens were probably of about equal size in life, the great difference in their lengths after preservation being largely or wholly due to the different states of contraction.

Ocelli.—Numerous conspicuous black ocelli of moderate size are situated on each lateral margin of the head (fig. 3). The number of such ocelli is from 35 to 50 on each side in each of the two specimens at hand. They extend in an elongated irregular cluster from near the proboscis pore along the lateral margins of the head backward nearly to the annular constriction separating head from body. About 8 of these ocelli are situated in a single marginal row on the snout itself, the others scattered irregularly on the main portion of the head. All are crescentic or cup shaped, with the concavity directed laterally.

When seen in prepared sections the ocelli appear to be highly developed, with well-marked lens and pigment cup. They are situated for the most part in the glandular portion of cutis immediately beneath the basement membrane of the integument, although a few are scattered in the deeper cephalic musculature. They extend posteriorly as far as the brain commissures, both of which occur in a single transverse section.

Color.—Definite color in life unknown, for after short preservation the body loses its general color, although it retains certain definite and characteristic markings. These markings consist of a series of narrow but sharply marked rings situated at fairly regular intervals throughout the whole length of the body (pl. 1, figs. 4, 5). After preservation the general ground-color of the body is very pale or whitish, while the rings are reddish brown and are always conspicuous from above, although they are often wanting on the ventral surface. The most anterior ring or rather transverse marking, is situated on the snout a short distance in front of the transverse groove and is incomplete, appearing on the dorsal surface only, and not extending laterally even as far as the groups of ocelli; the second is situated exactly in the region of the mouth and is interrupted on the ventral surface by the mouth opening;

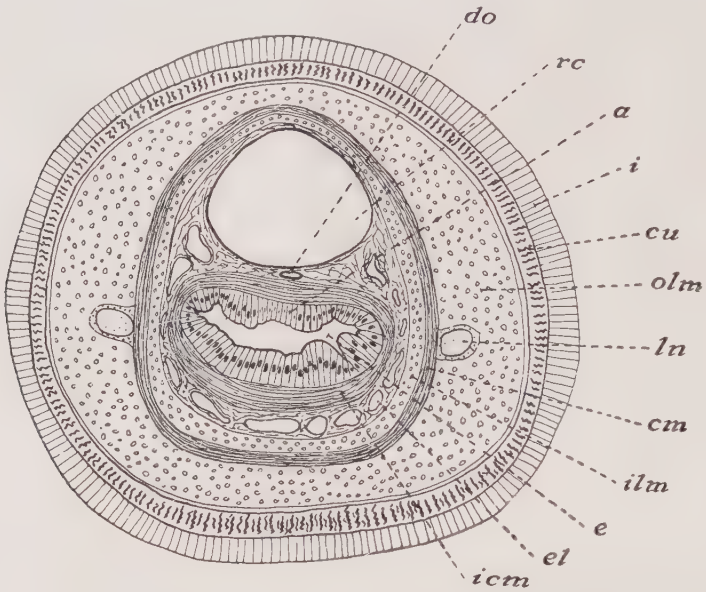


FIG. 4.—*Tæniosoma cingulatum* sp. nov. Transverse section of body through posterior end of esophageal region, showing the thick layer of circular muscles (*icm*) forming a sphincter about the posterior end of the esophagus (*e*); (*a*) groove of cells similar to those of stomach; (*do*) dorsal blood vessel; (*rc*) rhynchocœl; (*el*) esophageal blood lacunæ; (*ln*) lateral nerve. Other reference letters as in fig. 1. × 30.

then follow an irregular series of rings, some of which are complete while others are represented merely by transverse markings on the dorsal surface (pl. 1, fig. 5). All the rings are very narrow, but some are much finer than others and are indicated only by a few scattered dots.

In one of the two specimens collected the rings were for the most part complete, but were narrower on the ventral surface than dorsally, while in the other they were represented as transverse markings mainly confined to the dorsal surface. In the former specimen the body was contracted and the rings were separated from each other by considerably less than the body diameter (pl. 1, fig. 5), while in the other specimen, which was preserved in a fully extended state, the rings in the intestinal region were often separated by a space equal to three to five times the diameter of the body (pl. 1, fig. 4).

After having been preserved for a year in alcohol the specimens retain only faint indications of their original markings.

Proboscis.—Proboscis sheath short, extending only to anterior end of the intestinal region; composed of outer circular and inner longitudinal muscles (fig. 6). Proboscis small and weak, attached to tissues of head immediately anterior to brain commissures. Muscular walls of proboscis consisting

of an inner layer of longitudinal fibers and an outer, much thinner layer of circular fibers. Posterior end of proboscis attached to dorsal wall of sheath near its posterior end by strong longitudinal muscles. Fluid of rhynchocœle contains an abundance of large corpuscles, each with a conspicuous nucleus.

Body walls.—The relative thickness of the various layers which constitute the body walls is shown in figs. 4 and 5. Glandular layer of cutis three to four times as thick as the underlying fibrous layer. Outer longitudinal muscular layer massive, far exceeding in thickness the circular and inner longitudinal muscular layers combined (figs. 4, 5).

Cephalic glands.—As in most species of the genus, these glands are very voluminous. They occupy a great portion of the tissues of the head, and extend posteriorly for some distance into the esophageal region, where they are scattered among the bundles of the outer longitudinal muscular layer, as figured for *T. univittatum* (fig. 1).

Alimentary canal.—Mouth and esophagus as in related species. The esophagus opens posteriorly into a long chamber, the stomach, without diverticula, and this in turn passes gradually into the intestine proper.

At its posterior end the esophagus is surrounded by a well-developed layer of circular muscles, forming a strong sphincter (fig. 4, *icm*). These muscles are very limited in extent as a distinct layer, although they can be followed well forward in the esophageal region. Immediately in front of the opening of the esophagus into the intestine (fig. 4) they become fully equal in thickness to the circular muscular layer of the body walls. They are doubtless perfectly homologous with the inner circular muscular layer which surrounds the posterior end of the stomach in *Zygeupolia*, *Micrura*, and other forms, and which is apparently homologous with the inner circular muscular layer of the Paleonemertea.

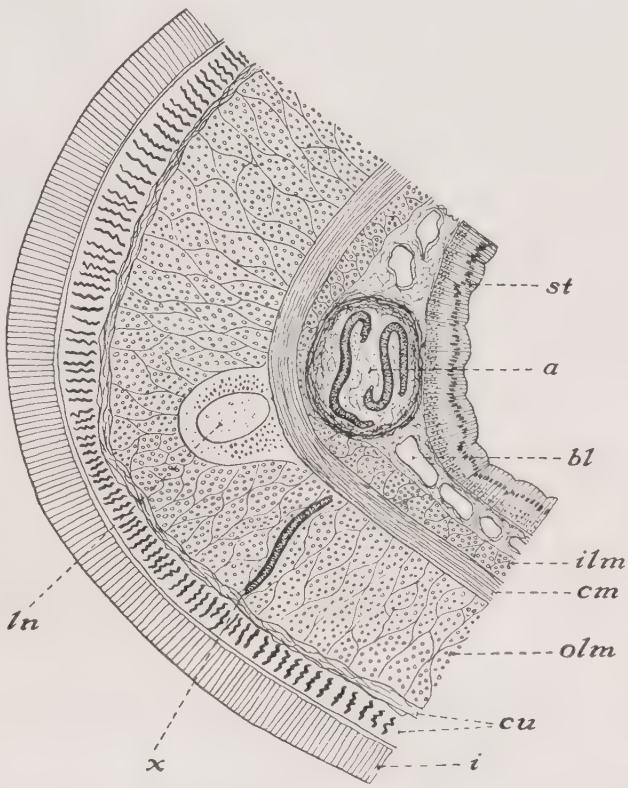


FIG. 5.—*Tæniosoma cingulatum* sp. nov. Portion of transverse section of body through anterior end of stomach region, showing peculiar cyst of fibrous tissue (*a*) containing two parasitic nematodes; a similar parasite (*x*) is shown in the outer longitudinal muscles; (*bl*) blood lacuna; (*ln*) lateral nerve. Other reference letters as in fig. 1. × 58.

The histological elements of the esophagus are sharply demarcated from those of the stomach, as in many other forms, and the change from esophagus to stomach is histologically as well as anatomically abrupt. Nevertheless, in one of the specimens sectioned a narrow band of epithelial cells (fig. 4, *a*) characteristic of the stomach extends forward for a short distance along the dorsal wall of the esophagus (*e*).

The transition from stomach to intestine, on the other hand, is so very gradual, both histologically and anatomically, that it is necessary to observe the arrangement of the blood vessels and the muscular layers in order to determine where the stomach region ends and the intestinal region begins.

The intestinal lobes are even less developed than in *T. univittatum*, and consequently the central lumen of the intestine is very large.

Blood vascular system.—Cephalic blood lacunæ as in related species; esophageal lacunæ voluminous, surrounding the lateral and ventral walls of the esophagus as closely placed anastomosing blood spaces of large size (figs. 4, 6, 7, *el*). In the stomach region these lacunæ decrease in number and size and eventually unite into a single pair of vessels, which later join the pair of lateral vessels situated in the

angle between stomach and proboscis sheath. In the intestinal region the lateral vessels lie beneath the intestine about halfway between the median line of body and the lateral border of intestine. The dorsal vessel occupies a position within the cavity of the rhynchocœl for only a very short distance immediately behind the brain. In the mouth region it passes through the proboscis sheath and becomes situated immediately ventral to the sheath throughout the length of the latter. At the posterior end of the proboscis sheath, in the anterior portion of the intestinal region, the dorsal vessel continues in the mid-dorsal line above the intestine to the posterior end of the body. Throughout the length of the intestinal region the dorsal vessel has frequent (metameric?) anastomoses with the lateral vessels.

Nephridia.—The nephridial canals are remarkable in that they have numerous efferent ducts which open into the lumen of the esophagus (figs. 6, 7, *nd*), as well as others which open on the external surface of the body. This remarkable condition is known in but one other species of nemertean, which also belongs to the genus *Tæniosoma*. This is *T. melanogrammum* (Punnett), a new name proposed for

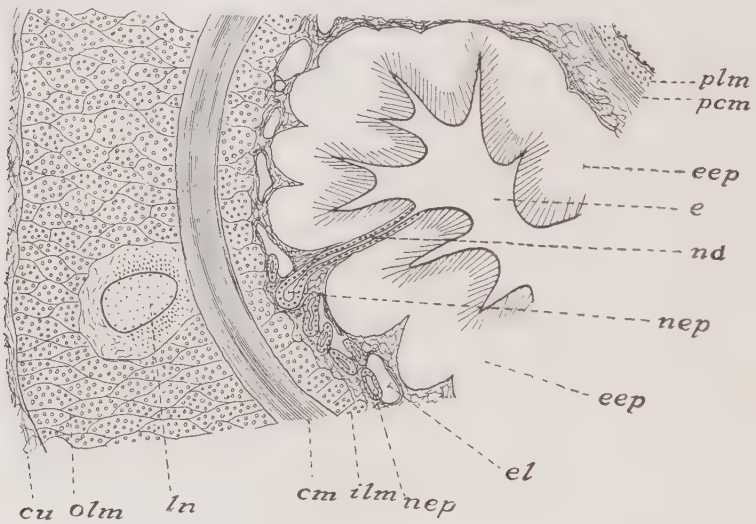


FIG. 6.—*Tæniosoma cingulatum*. Portion of transverse section of body through esophageal region, showing arrangement of blood lacunæ (*el*), nephridial canals (*nep*), and nephridial duct (*nd*) opening through esophageal epithelium (*eep*) into lumen of esophagus (*e*); (*plm* and *pcm*) longitudinal and circular muscles of proboscis sheath; (*ln*) lateral nerve. Other reference letters as in fig. 1. × 90.

T. quinquelineatum (Quoy et Gaimard). In this species Punnett[a] has found in each of two specimens sectioned a number of efferent nephridial ducts opening directly through the esophageal epithelium into the lumen of the esophagus, in addition to a somewhat smaller number opening above the lateral nerves to the dorso-lateral surface of the body. The ducts opening externally are interspersed irregularly between those opening into the esophagus. Exactly similar conditions prevail in *T. cingulatum*, as stated above.

The nephridial tubules are profusely branched and rather extensive, being found throughout the posterior three-fifths of the esophageal region. The branches are themselves of rather large size and are situated on the lateral walls of the esophageal blood lacunæ (figs. 6, 7) and in close contact with the epithelial lining of the blood spaces. The efferent ducts which open into the esophagus are conspicuous in many instances and show a distinct, though thin-walled, tube (figs. 6, 7, *nd*) passing directly from one of the larger nephridial canals (*nep*) to the surface of the ciliated epithelium lining the esophagus. The efferent duct itself is lined with flattened cells and often presents a distinct lumen throughout its length, so that there is not the slightest doubt of the communication between the nephridial canals and the lumen of the esophagus.

[a] Quart. Journ. Micr. Sci., vol. 44, 1900, p. 116.

The esophageal epithelium is thrown up into numerous temporary longitudinal ridges of varying size and thickness. Some of the nephridial ducts open in the grooves between these ridges, as shown in fig. 7, while others open near or at the summit of the ridges (fig. 6). With varying degrees of extension of the walls of the esophagus and the consequent change in the height of the longitudinal ridges must occur great variations in the length of the efferent nephridial ducts.

Both of the two specimens sectioned presented similar conditions, although the number of such efferent ducts is somewhat different in each and on the two sides of the body. The actual number is difficult to determine with certainty, but is apparently between 7 and 20 on each side of the body.

A smaller number of similar ducts open on the dorso-lateral surfaces of the body. These, too, originate directly from the larger nephridial canals, but whether there is actual communication between the canals opening externally and those opening into the esophagus could not be determined. The canals are much twisted and bent upon themselves, as well as being profusely branched, so that numerous sections of the canal occur in each transverse section of the body (figs. 6, 7).

The ducts opening externally are interspersed irregularly between those opening into the esophagus, but the average position of the former is somewhat more anterior than that of the latter. Those opening externally are narrower and somewhat less conspicuous than the others.

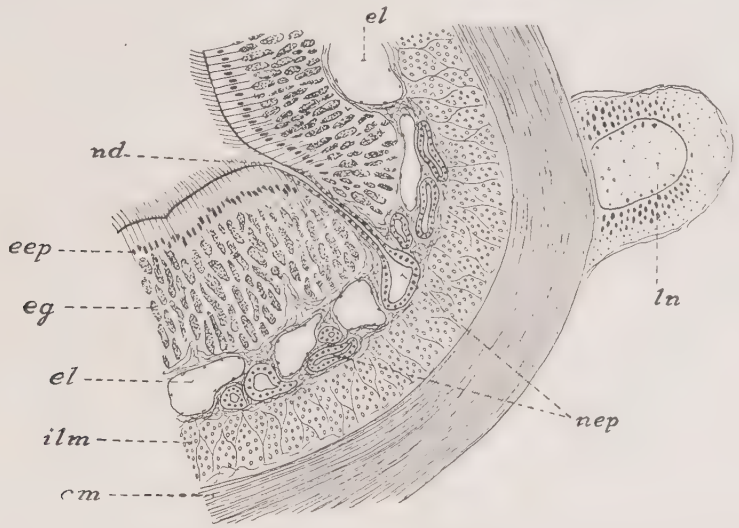


FIG. 7.—*Tæniosoma cingulatum* sp. nov. Portion of transverse section of body through middle of esophageal region, showing efferent nephridial duct (*nd*) opening through esophageal epithelium (*eep*) into lumen of esophagus; (*nep*) nephridial canals, situated beside and external to the esophageal blood lacunæ (*el*); (*eg*) esophageal glands; (*ln*) lateral nerve. Other reference letters as in fig. 1. × 150.

Although the two species mentioned above are the only nemerteans in which the nephridia are known to open into the esophagus, yet in one other species of the same genus, *T. indicum* (*Eupolia indica* Punnett[a]), fine cords of cells, resembling "delicate ducts compressed to obscure the lumen, pierce the glandular layer of the esophagus and may be traced to the esophageal epithelium," although Punnett suggests that they are not functional. He was, however, unable to find any traces of other efferent ducts leading to the exterior of the body.

Nervous system.—The most remarkable peculiarity of the nervous system is the presence of unusually large and numerous buccal or esophageal nerves. In the mouth region there are 4 to 6 large branches on each side, which together constitute a bulk nearly equal to the core of the lateral nerve in the same region. The buccal nerves are united with each other shortly after their origin from the brain and exhibit similar unions with the lateral nerves in the mouth region.

Reproductive organs.—Sexual products not present in specimens collected in April.

Parasites.—Both the specimens sectioned were infested with parasitic nematode worms which formed large and conspicuous cysts or tumors in the connective tissue between the esophageal epithelium

[a] Gardner's Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. 1, part 1, Nemerteans, p. 104. 1901.

and the lateral nerves (fig. 5, *a*). Such cysts commonly exceed the lateral nerve in diameter, and in one specimen were scattered irregularly through the posterior portion of the esophageal region backward into the intestinal region. Not all of the cysts contained the parasites, however, and in some cases the parasitic worms were found imbedded in the body walls, principally in the outer longitudinal muscular layer (fig. 5, *x*). When found in other places than in the cysts referred to the parasites were quite free among the tissues, presenting an appearance as if they had wandered from the cysts toward the exterior of the body. The cysts themselves are composed of an irregular network of fibrous tissue supporting numerous large, oval nuclei. A firmer layer of the same tissue makes up the external wall of the cyst, which is completely filled with tissue except for the space actually occupied by the parasite. Occasionally two or three such parasites were found in a single cyst (fig. 5, *a*). In the second specimen sectioned only a few such cysts were present. The length of the parasitic nematode varies from 0.2 to 0.3 mm.; the width is about 0.017 mm.

Habitat.—Dredged in 21 to 28 fathoms in Auau Channel, between Maui and Lanai islands (station 3874). Bottom composed of sand, pebbles, and shells; temperature 75.3° F. Also dredged in 28 to 43 fathoms near same locality (station 3876). Bottom composed of sand and gravel, with a temperature of 74° F.

The species is therefore known only from the Hawaiian Islands.

Drepanophorus sp.?

The genus *Drepanophorus* is represented in this collection by a single proboscis only, so that the specific identity of the form represented remains unknown. The preserved proboscis measures 33 mm. in length and 4 mm. in diameter. It must therefore have belonged to a worm of fairly large size. The armature was not well preserved. The general features of basis and stylets could be made out, but no details of structure. It is provided with 26 large and conspicuous nerves.

The color of this proboscis is described as uniform rose pink in life, but is colorless after preservation.

Apparently no species of the genus has been heretofore found which had exactly 26 proboscidial nerves, although the widely distributed *D. spectabilis* has 24, and several other forms 30 or more.

This proboscis was collected at station 4117, off the northwest coast of Oahu Island, at a depth of between 253 and 282 fathoms. The bottom at this locality was composed of coral sand and foraminifera, and had a temperature of 45.6° F.

It is unfortunate that the worm itself was not obtained, for it would be extremely interesting to determine whether a representative of a genus in which the ocelli are usually so highly developed would retain them unimpaired at a depth of more than 250 fathoms, where it must live in absolute darkness. It may be noted in this connection that Punnett has recently found a species of *Lineus*[a] living in the fjords of Norway at a nearly equal depth which has numerous small ocelli. He looks upon this as a recent immigrant from shallower arctic seas into the deeper waters of the fjords, because most other deep-water nemerteans have been found to be destitute of ocelli.

EXPLANATION OF PLATE.

Tæniosoma univittatum sp. nov.

Fig. 1. Preserved specimen moderately extended; × 5.

2. Preserved specimen strongly contracted; × 5.

Fig. 3. Dorsal side of head and anterior portion of body, showing position and anterior extent of dorsal longitudinal marking; × 8.

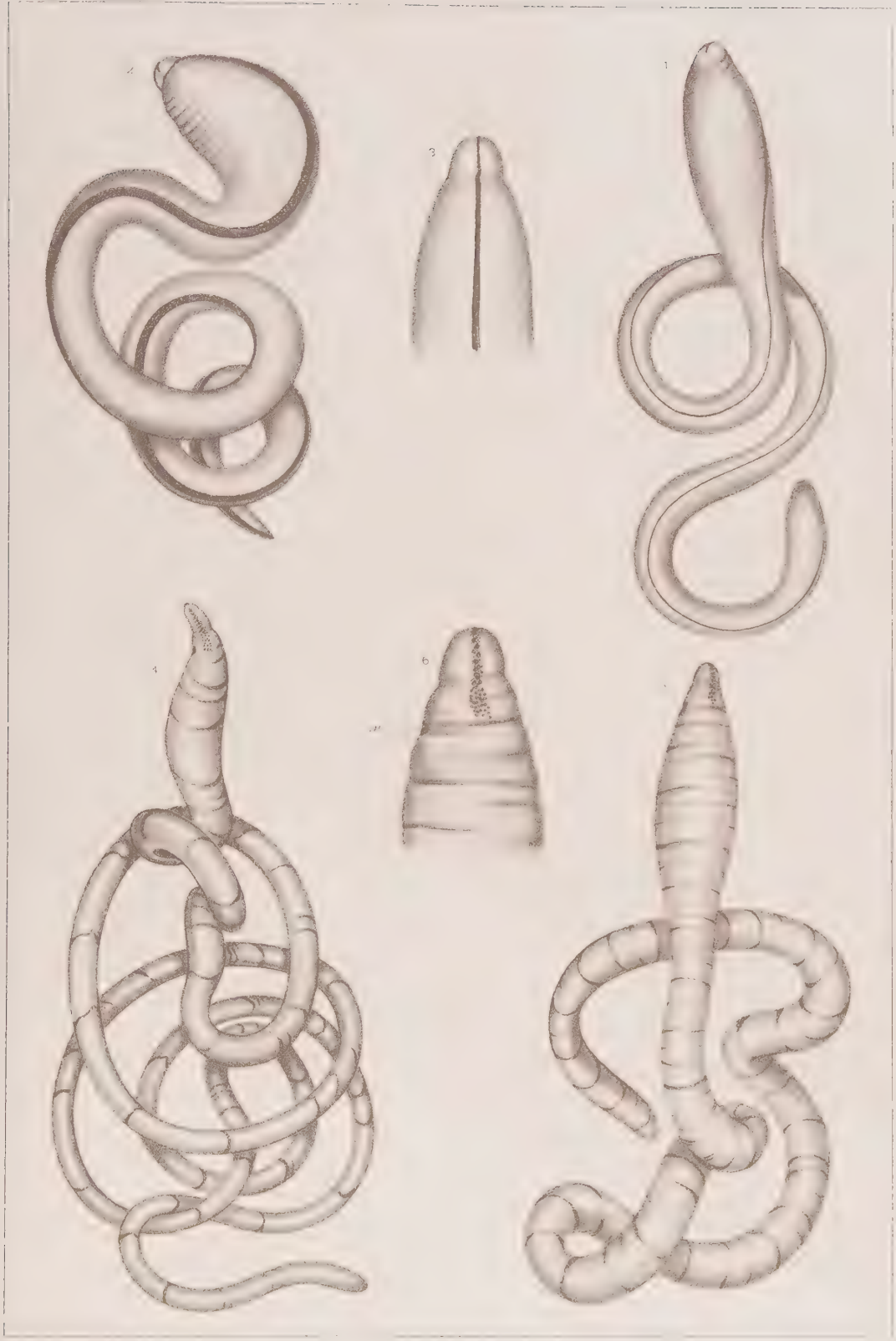
Tæniosoma cingulatum sp. nov.

Fig. 4. Specimen preserved in a well-extended condition; head and anterior portion of body seen from lateral surface; × 3.

5. Preserved specimen somewhat contracted; position of head as in preceding figure; × 3.

Fig. 6. Head and anterior portion of body of contracted specimen more highly enlarged; showing numerous ocelli on lateral margin of head; *m*, mouth; × 6.

[a] *L. cinereus* Punnett, Bergen's Museum Aarbog, 1903, p. 17.



FIGS. 1-3 TÆNIOSOMA UNIVITTATUM COE, NEW SPECIES.

FIGS. 4-6 TÆNIOSOMA CINGULATUM COE, NEW SPECIES.

THE STARFISHES OF THE HAWAIIAN ISLANDS.

By WALTER K. FISHER,

Acting Instructor in Zoology, Leland Stanford Junior University.

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INTRODUCTION.

The specimens upon which the following report is based were collected by the U. S. fisheries steamer *Albatross* among the Hawaiian Islands during the spring and summer of 1902. A small collection taken off the south coast of Oahu by the *Albatross* in 1891 has likewise been examined, and there must also be added a single example of "*Goniodiscus*" *sebæ*, collected by Mr. H. W. Henshaw in the vicinity of Hilo, Hawaii. Altogether the collection numbers very nearly 1,650 specimens, and includes 60 species, of which 52 are new to science, 5 are for the first time recorded from the Hawaiian Islands, and 3 are too young or in too poor condition for naming. In other words, the *Albatross* took but 1 species that had been previously reported from the region. Ten species which had been recorded were not secured by the *Albatross* expedition.

The present report may be considered a monographic account of Hawaiian starfishes which occur between the shore and the thousand-fathom line. In their proper places I have listed the 10 species already recorded from the islands which were not secured by the *Albatross*. It is certainly surprising that such forms as *Archaster typicus*, *Gymnasteria carinifera*, *Asterina granulosa*, *Culcita arenosa*, or *Heliaster multiradiata*, all very shallow-water forms and usually occurring on shores or reefs, were not taken. The most important collecting grounds in the future will be the very shallow water near shore, on the windward sides of the islands. If hempen tangles are dragged over the bottom, undoubtedly other widely distributed species will be found. Coral reefs (not the exposed ones) should be most prolific.

I have included keys, and in a chapter at the end of the article have listed the principal technical terms; but the general naturalist will find, as a rule, that the figures of the whole animal are a quicker and surer means of identification. Unfortunately a number of the shallow-water species can not be figured.

The arrangement of families in this report does not follow exactly that of any previous author, but in general may be said to be modeled after Sladen and Perrier as modified by Verrill. It is very difficult to arrange the socalled families of starfishes satisfactorily in serial order, just as it is difficult in other groups. Thus, in placing the Luidiidæ between the Astropectinidæ and Pseudarchasteridæ, it is not

meant that the family holds an intermediate position, because nothing could be much farther from the truth. But since the Luidiidæ are a very specialized offshoot from the proastropectinoid stock, there is no other position for the group. Similar apologies should be made for the Benthopectinidæ and the Archasteridæ.

In the matter of the orders I have made a compromise between Sladen's and Perrier's and Verrill's modifications of these. Sladen's Phanerozonia is used in nearly the same sense in which he employed the term in the "Challenger Asteroidea." The Linckiidæ, being phanerozoniate, are taken out of Sladen's Cryptozonia and placed in the Phanerozonia, in which order they undoubtedly belong; while the Asterinidæ (and Anseropodidæ) being cryptozoniate, are removed from the Phanerozonia. I believe Perrier's arrangement of the cryptozoniate families under two orders (he has apparently abandoned the Velata) is rather more felicitous than that of Sladen under one large heterogeneous order (Cryptozonia), and I have consequently followed Perrier with small modifications. It must be remembered, however, that there is a great difference of opinion concerning the extent of the orders of Asteroidea. Some writers follow Sladen and some Perrier. As pointed out recently by Professor Verrill (1899), Perrier's Paxillosa and Valvata (=Phanerozonia emended) are decidedly artificial groups. I do not go so far as Professor Verrill in considering them suborders, because unless some more fortunate grouping of families is devised, the difficulty is merely temporarily pigeon-holed.

Returning to the families, it will be noted that I have followed Verrill in dismembering the great "family" of the Archasteridæ. I have accepted most of Verrill's modifications and have raised the Pseudarchasterinæ to family rank. I can not agree with Professor Verrill that the Pontasterinæ constitute a subfamily of the Plutonasteridæ, but have relegated the group to the Benthopectinidæ (=Pararchasterinæ Sladen), a position more nearly in accord with the views of Sladen. The sequence of families is new so far as the Phanerozonia are concerned. The order starts with the more specialized paxillose forms, with very well developed superambulacral ossicles, and proceeds through those in which the paxillæ are often rudimentary or reduced and the superambulacral plates not always present to those in which the latter are always absent. Then, beginning with the Mediasterinæ, the transition is gradual toward forms with less paxilliform plates, to those with granular or smooth abactinal plates, and bivalved or foraminate pedicellariæ; then to the skin-covered forms, with stellate or stellate-reticulate abactinal skeleton and low bivalved pedicellariæ. The Linckiidæ, though placed at the end, are in many respects distinctly related to some of the Goniasteridæ. They often have excavate pedicellariæ. The Gymnasteriidæ are rather intermediate forms. In the Spinulosa and Forcipulata the sequence is practically that given by Perrier. The Velata are merged with the Spinulosa. In many respects the classification of the Asteroidea is difficult, especially on account of the number of more or less perfect transitional forms which render family boundaries extremely unstable.

So far as I am aware there have been no special papers on Hawaiian starfishes. The few references are widely scattered and a number of records are given second hand, the original citation being unknown to me. A number of records are very incidental in mention, and it is probable that a few have escaped notice. A bibliography of papers quoted in the following report is appended.

The writer had the good fortune to be a member of the scientific staff during the expedition, and in case of most species made color notes while the animals were still fresh. Ridgway's "Nomenclature of Colors for Naturalists" was used.[a]

SYNOPSIS OF HAWAIIAN STARFISHES.

[Those marked with an asterisk (*) were not taken by the *Albatross* expedition.]

Order Phanerozonia Sladen.
- Family Astropectinidæ Gray.
  - Genus Astropecten Schulze.
    - Astropecten polyacanthus Müller and Troschel.
    - Astropecten velitaris Von Martens.
    - Astropecten ctenophorus, n. sp.
    - Astropecten pusillulus, n. sp.
    - Astropecten productus, n. sp.
    - Astropecten callistus, n. sp.
  - Genus Ctenophoraster n.
    - Ctenophoraster hawaiiensis, n. sp.
  - Genus Tritonaster n.
    - Tritonaster craspedotus, n. sp.
  - Genus Psilaster Sladen.
    - Psilaster attenuatus, n. sp.
  - Genus Psilasteropsis n.
    - Psilasteropsis cingulata, n. sp.
  - Genus Dipsacaster Alcock.
    - Dipsacaster nesiotes, n. sp.
  - Genus Papagiaster n.
    - Patagiaster nuttingi, n. sp.
- Family Luidiidæ Verrill.
  - Genus Luidia Forbes.
    - Luidia hystrix, n. sp.
    - Luidia magnifica, n. sp.
    - Luidia brevispina Lutken.*
- Family Pseudarchasteridæ Fisher.
  - Genus Pseudarchaster Sladen.
    - Pseudarchaster myobrachius, n. sp.
    - Pseudarchaster jordani, n. sp.
- Family Benthopectinidæ Verrill.
  - Subfamily Pontasterinæ Verrill.
    - Genus Cheiraster Studer.
      - Cheiraster snyderi, n. sp.
      - Cheiraster horridus, n. sp.
      - Cheiraster inops, n. sp.

[a] I am indebted to Dr. Charles H. Gilbert, naturalist in charge of the Hawaiian explorations, and to Prof. A. E. Verrill, of Yale University, for advice in my work on this collection and assistance in the determination of difficult species, and I desire to acknowledge my obligations also to Mr. Henry W. Fowler, of the Philadelphia Academy of Natural Sciences, and to Mr. Wilfred H. Osgood and Mr. Nelson H. Kent, of the U. S. Biological Survey, for copies of several original descriptions and photographs of three small specimens.

Order Phanerozonia Sladen—Continued.
Family Archasteridæ Viguier.
Genus Archaster Müller and Troschel.
Archaster typicus Müller and Troschel.*
Family Goniasteridæ Forbes.
Subfamily Mediasterinæ Verrill.
Genus Mediaster Stimpson.
Mediaster ornatus, n. sp.
Genus Nereidaster Verrill.
Nereidaster bowersi, n. sp.
Subfamily Goniasterinæ Verrill.
Genus Pentagonaster Gray.
Pentagonaster ammophilus, n. sp.
Genus Tosia Gray.
Subgenus Plinthaster Verrill.
Tosia (Plinthaster) ceramoidea, n. sp.
Subgenus Ceramaster Verrill.
Tosia (Ceramaster) micropelta, n. sp.
Genus Astroceramus n.
Astroceramus callimorphus, n. sp.
Genus Calliderma Gray.
Calliderma spectabilis, n. sp.
Genus Calliaster Gray.
Calliaster pedicellaris, n. sp.
Genus Gilbertaster n.
Gilbertaster anacanthus, n. sp.
Subfamily Hippasteriinæ Verrill.
Genus Evoplosoma n.
Evoplosoma forcipifera, n. sp.
Subfamily Leptogonasterinæ Perrier.
Genus Antheniaster Verrill.
Antheniaster epixanthus, n. sp.
Subfamily Goniodiscidinæ, new name.
Genus Goniodiscides, new name.
Goniodiscides sebæ (Müller and Troschel).
Family Pentacerotidæ Gray.
Genus Pentaceros Schulze.
Pentaceros hawaiiensis, n. sp.
Genus Nidorellia Gray.
Nidorellia armata (Gray).*
Genus Asterodiscus Gray.
Asterodiscus tuberculosus, n. sp.
Genus Culcita Agassiz.
Culcita arenosa Perrier.*

Order Phanerozonia Sladen—Continued.
Family Linckiidæ Perrier.
Genus Ophidiaster Agassiz.
Ophidiaster lorioli, n. sp.
squameus, n. sp.
triseriatus, n. sp.
sclerodermus, n. sp.
tenellus, n. sp.
rhabdotus, n. sp.
Genus Leiaster Peters.
Leiaster callipeplus, n. sp.
Genus Linckia Nardo.
Linckia diplax (Müller and Troschel).
multifora (Lamarck).*
Genus Nardoa Gray.
Nardoa ægyptiaca (Gray).*
Family Gymnasteriidæ Perrier.
Genus Gymnasteria Gray.
Gymnasteria carinifera (Lamarck).*
Order Spinulosa Perrier.
Family Asterinidæ Gray.
Genus Asterina Nardo.
Asterina granulosa Perrier.*
Family Anseropodidæ n.
Genus Anseropoda Nardo.
Anseropoda insignis, n. sp.
Family Echinasteridæ Verrill.
Subfamily Echinasterinæ Viguier.
Genus Henricia Gray.
Henricia robusta, n. sp.
Henricia pauperrima, n. sp.
Genus Echinaster Müller and Troschel.
Echinaster, sp.
Subfamily Valvasterinæ Viguier.
Genus Valvaster Perrier.
Valvaster striatus (Lamarck).
Family Mithrodiidæ Perrier.
Genus Mithrodia Gray.
Mithrodia bradleyi Verrill.
Family Myxasteridæ Perrier.
Genus Asthenactis, n.
Asthenactis papyraceus, n. sp.
Family Pterasteridæ Perrier.
Genus Pteraster Müller and Troschel.
Pteraster reticulatus, n. sp.

Order Spinulosa Perrier—Continued.
Family Pterasteridæ Perrier—Continued.
Genus Hymenaster Wyville Thomson.
Hymenaster pentagonalis, n. sp.
Genus Benthaster Sladen.
Benthaster eritimus, n. sp.
Order Forcipulata Perrier.
Family Zoroasteridæ Sladen.
Genus Zoroaster Wyville Thomson.
Zoroaster spinulosus, n. sp.
Family Heliasteridæ Viguier.
Genus Heliaster Gray.
Heliaster multiradiata (Gray).*
Family Asteriidæ Gray.
Genus Coscinasterias Verrill.
Subgenus Distolasterias Perrier.
Coscinasterias (Distolasterias) euplecta, n. sp.
Genus Hydrasterias Sladen.
Hydrasterias verrilli, n. sp.
Family Brisingidæ Sars.
Genus Odinia Perrier.
Odinia pacifica, n. sp.
Brisinga Asbjørnsen.
Brisinga panopla, n. sp.
Brisinga alberti, n. sp.
Brisinga evermanni, n. sp.
Brisinga fragilis, n. sp.

There is proposed to replace *Goniodiscus*, which is untenable, the new generic name *Goniodiscides*, type *G. sebæ* (Müller and Troschel). See p. —.

One new family is established, Anseropodidæ, which equals the Palmipedinæ. The new name Goniodiscidinæ is proposed to replace Goniodiscinæ, on account of change of *Goniodiscus*.

Species for the first time recorded from the Hawaiian Group are *Astropecten polyacanthus*, *Goniodiscides sebæ*, *Astropecten velitaris*, *Linckia diplax*, *Valvaster striatus*.

One previously reported species was taken by the *Albatross*, *Mithrodia bradleyi* (sub nomine *clavigera*).

Species recorded from the Hawaiian Islands but not taken by the *Albatross* are listed below:

Luidia brevispina
Archaster typicus
Nidorellia armata
Culcita arenosa
Ophidiaster pusillus (?)
Linckia multifora
Nardoa ægyptiaca
Gymnasteria carinifera
Asterina granulosa
Heliaster multiradiata

From these lists it will be readily seen that previous to the expedition of 1902 only 11 starfishes (so far as I have been able to learn) were known from the region

and that the *Albatross* added nearly 5 times that number of species which are either new or constitute new records.

Although dredging in Hawaiian waters proved to be an undertaking which presented unusual difficulties, it is safe to say that no other area of similar extent has been so thoroughly developed or has yielded better results. With certain exceptions, the sea bottom, especially in the lesser depths, is very uneven and rough; during the progress of the work it frequently happened that when a haul was nearly successfully completed the gear would catch on some obstruction on the bottom, and a large part or the whole contents of the trawl would be lost. Off the north coast of Maui, however, and in certain restricted areas in the Pailolo Channel between Maui and Molokai good dredging was afforded, and it was in this general region that many of the novelties were taken.

List of "Albatross" dredging stations at which starfishes were secured, with the species taken at each.

Station.	Locality.	Depth.	Nature of bottom.	Species.
		Fathoms.		
3810	South coast of Oahu Island	211- 53	Fine coral sand	Astropecten callistus.
3813	do	264-183	Coral sand, lava specks, shells	Antheniaster epixanthus.
3817	do	320	Coarse lava, coral sand, shells	Brisinga fragilis.
3824	South coast of Molokai Island	222-498	Coral rocks, broken shells	Psilasteropsis cingulata, Benthaster eritimus, Brisinga fragilis.
3828	do	319-281	Broken shells, gravel	Odinia pacifica, Brisinga panopla.
3834	do	Shore.	Coral reef	Ophidiaster lorioli.
3835	do	169-182	Fine brown sand, mud	Astropecten callistus, Anseropoda insignis, Coscinasterias euplecta.
3836	do	238-255	Brownish-gray mud and sand	Patagiaster nuttingi.
3838	do	92-212	Fine grayish brown sand	Calliderma spectabilis.
3847	do	23- 24	Sand, stones	Mithrodia bradleyi.
3848	do	43- 73	Sand, gravel	Linckia diplax.
3849	do	73- 43	Coarse sand, broken shells, coral.	Astropecten velitaris, Luidia magnifica, Pentaceros hawaiiensis.
3850	do	43- 66	do	Pentaceros hawaiiensis.
3857	Pailolo Channel between Maui and Molokai islands and northeast approach.	127-128	Fine sand, yellow mud	Astroceramus callimorphus.
3859	do	138-140	Fine sand and mud	Coscinasterias euplecta.
3861	do	30- 52	Fine sand, small pebbles, coral	Luidia hystrix.
3865	do	256-283	Fine volcanic sand, rocks	Astropecten pusillulus, Psilaster attenuatus, Cheiraster inops, Tosia ceramoidea, Brisinga fragilis.
3866	do	283-284	Gray mud, fine sand	Psilaster attenuatus, Dipsacaster nesiotes.
3867	Northeast approach to Pailolo Channel.	284-290	Fine sand and mud	Psilaster attenuatus, Dipsacaster nesiotes, Pteraster reticulatus.
3868	do	294-684	Fine gray sand, rocks	Dipsacaster nesiotes, Cheiraster inops.
3871	Auau Channel, between Maui and Lanai islands.	13- 43	Fine white sand	Mithrodia bradleyi.
3872	do	43- 32	Yellow sand, pebbles, coral	Pentaceros hawaiiensis, Leiaster callipeplus, Linckia diplax, Mithrodia bradleyi.
3875	do	65- 34	Fine gray sand	Leiaster callipeplus.
3876	do	28- 43	Sand and gravel	Luidia hystrix, Mithrodia bradleyi.
3883	Pailolo Channel, between Maui and Molokai islands.	277-284	Globigerina ooze	Psilaster attenuatus, Tosia ceramoidea.
3884	do	284-290	Globigerina mud	Psilaster attenuatus, Dipsacaster nesiotes.
3885	do	136-148	Sand, pebbles	Coscinasterias euplecta.
3887	North coast of Molokai Island	552-809	Globigerina mud	Psilasteropsis cingulata.
3892	do	328-414	Fine gray sand	Zoroaster spinulosus, Brisinga fragilis.
3908	South coast of Oahu Island	304-308	Fine white sand and mud	Psilaster attenuatus, Dipsacaster nesiotes.
3909	do	308-322	do	Psilaster attenuatus.
3910	do	311-337	Fine gray sand and mud	Psilaster attenuatus, Dipsacaster nesiotes, Brisinga fragilis.
3911	do	337-334	do	Psilaster attenuatus, Hymenaster pentagonalis.
3914	do	289-292	Gray sand and mud	Tritonaster craspedotus, Hymenaster pentagonalis, Brisinga fragilis.
3916	do	299-330	do	Psilaster attenuatus.
3917	do	330-294	do	Do.
3918	do	294-257	White sand, mud	Astropecten pusillulus, Psilaster attenuatus, Tritonaster craspedotus.
3919	do	257-220	Gray sand	Tritonaster craspedotus, Patagiaster nuttingi, Pentagonaster ammophilus.
3920	do	280-265	Gray sand, broken shells	Brisinga fragilis.

List of "Albatross" dredging stations at which starfishes were secured, with the species taken at each—Cont'd.

Station.	Locality.	Depth.	Nature of bottom.	Species.
		Fathoms.		
3935	Vicinity of Laysan Island	57–79	White sand, broken shells, coralline.	Ctenophoraster hawaiiensis.
3937	do	130–148	White sand, small shells	Astropecten ctenophorus.
3938	do	148–63	White sand, broken shells	Calliderma spectabilis.
3940	do	59–70	do	Asterodiscus tuberculosus.
3957	do	220–173	Fine white sand	Astropecten callistus.
3960	do	10–19	Sand, shells, coral	Mithrodia bradleyi.
3975	Necker Island shoal	16–171	Coarse sand, coral, shells	Do.
3978	Vicinity of Bird Island	32–46	Coral, sand, foraminifera, rocks	Do.
3981	Vicinity of Kauai Island	636–414	Globigerina ooze	Cheiraster snyderi.
3982	do	233–40	Coarse brown coral sand, shells	Ophidiaster rhabdotus.
3987	do	55–50	Coarse coral sand, coral fragments.	Luidia hystrix.
3992	do	400–500	Fine gray sand, mud	Odinia pacifica, Brisinga panopla, Brisinga alberti, Brisinga sandwichensis.
3995	do	427–676	Fine gray sand, rocks	Psilasteropsis cingulata, Cheiraster snyderi, Pseudarchaster myobrachius.
3997	do	418–429	Fine gray sand, brown mud	Psilasteropsis cingulata, Cheiraster snyderi, Mediaster ornatus.
3998	do	235–228	Coarse brown coral sand, shells, rocks.	Cheiraster snyderi.
4007	do	508–557	Gray sand, foraminifera	Cheiraster snyderi, Zoroaster spinulosus.
4019	do	550–409	Gray sand, rocks, foraminifera	Mediaster ornatus.
4021	do	286–399	Coral sand, foraminifera	Do.
4022	do	399–374	Coral sand, rocks, foraminifera	Do.
4023	do	18–41	Gray sand, foraminifera, coral, rocks.	Ophidiaster squameus.
4024	do	24–43	Coarse coral sand, foraminifera	Mithrodia bradleyi.
4027	do	319	Fine gray sand, rocks	
4028	do	444–478	Gray sand, globigerina	Psilasteropsis cingulata, Pseudarchaster myobrachius, Mediaster ornatus.
4031	Penguin Bank, off south coast Oahu Island.	27–28	Coral, fine coral sand, foraminifera.	Astropecten velitaris, Luidia hystrix.
4032	do	27–29	Fine coral sand, foraminifera	Luidia hystrix.
4034	do	28–14	do	Luidia hystrix, Mithrodia bradleyi.
4041	West coast Hawaii Island	382–253	Gray mud, foraminifera	Gilbertaster anacanthus, Brisinga fragilis.
4044	do	233–198	Fine gray sand	Astropecten pusillulus, Astropecten callistus, Patagiaster nuttingi, Henricia pauperrima.
4045	do	198–147	Coral sand, foraminifera	Astropecten callistus, Coscinasterias euplecta.
4046	do	147–71	do	Mithrodia bradleyi.
4048	do	374	Fine gray sand, rocks	Astropecten pusillulus.
4055	Northeast coast Hawaii Island (Hilo Bay).	50–62	Fine gray sand, foraminifera	Astropecten velitaris.
4062	Northeast coast Hawaii Island.	83–113	Coral, volcanic sand, shells, foraminifera.	Mithrodia bradleyi, Coscinasterias euplecta.
4064	do	63–107	Volcanic sand, foraminifera, coral.	Coscinasterias euplecta.
4066	Aleunihana Channel, between Hawaii and Maui islands.	176–49	Rocky	Do.
4072	North coast of Maui island	56–59	Coarse coral sand, foraminifera	Pentaceros hawaiiensis.
4074	do	78–85	Coral sand, foraminifera	Calliderma spectabilis.
4075	do	49–57	Fine gray sand, foraminifera	Pentaceros hawaiiensis.
4077	do	99–106	Fine coral sand, foraminifera	Calliderma spectabilis, Ophidiaster sclerodermus.
4079	do	143–178	Gray sand, foraminifera	Astropecten callistus, Cheiraster horridus, Calliderma spectabilis, Coscinasterias euplecta.
4080	do	178–202	do	Astropecten callistus, Antheniaster epixanthus.
4081	do	202–220	do	Astropecten pusillulus, Pentagonaster ammophilus, Antheniaster epixanthus.
4082	do	220–238	Gray sand	Astropecten pusillulus, Patagiaster nuttingi, Pentagonaster ammophilus, Tosia ceramoidea, Antheniaster epixanthus.
4083	do	238–253	do	Astropecten pusillulus, Patagiaster nuttingi, Pentagonaster ammophilus.
4084	do	253–267	Fine gray sand	Astropecten pusillulus, Antheniaster epixanthus.
4085	do	267–283	Sand, shells	Astropecten pusillulus.
4086	do	283–308	do	Psilaster attenuatus.
4087	do	308–306	Fine gray sand	Do.
4088	do	306–297	do	Do.
4089	do	297–304	do	Do.
4090	do	304–308	do	Psilaster attenuatus, Hymenaster pentagonalis, Brisinga fragilis.
4091	do	308–306	do	Psilaster attenuatus, Brisinga fragilis.

List of "Albatross" dredging stations at which starfishes were secured, with the species taken at each—Cont'd.

Station.	Locality.	Depth.	Nature of bottom.	Species.
		Fathoms.		
4095	NE. approach to Pailolo Channel between Maui and Molokai islands.	290–286	Brown mud, fine sand, globigerina.	Psilaster attenuatus.
4096	.....do	272–286	Fine gray sand	Astropecten pusillulus, Psilaster attenuatus, Tosia ceramoidea, Brisinga fragilis.
4098	North coast of Maui Island	95–152	Coral sand, foraminifera, rocks.	Calliderma spectabilis.
4100	Pailolo Channel between Maui and Molokai islands.	130–151	Coarse sand, shells, foraminifera.	Calliaster pedicellaris, Ophidiaster squameus, Ophidiaster tenellus, Coscinasterias euplecta.
4101	.....do	143–122	.....do	Astropecten productus, Anseropoda insignis, Coscinasterias euplecta.
4102	.....do	122–132	.....do	Astropecten productus, Calliderma spectabilis.
4112	Kaiwi Channel between Molokai and Oahu islands.	447–433	Fine sand	Zoroaster spinulosus.
4114	Northwest coast of Oahu Island.	154–195	Coral sand, foraminifera	Astropecten callistus.
4115	.....do	195–241	.....do	Patagiaster nuttingi, Antheniaster epixanthus, Henricia robusta.
4116	.....do	241–282	.....do	Astropecten pusillulus.
4123	Southwest coast of Oahu Island.	352–357	Fine gray sand, mud	Psilasteropsis cingulata, Patagiaster nuttingi, Mediaster ornatus.
4128	Vicinity of Kauai Island	68– 90	Coarse brown coral sand, foraminifera.	Asterodiscus tuberculosus, Leiaster callipeplus, Ophidiaster triseriatus.
4131	.....do	309–257	Fine gray sand	Brisinga fragilis.
4132	.....do	257–312	Fine gray sand, mud	Nereidaster bowersi.
4134	.....do	324–225	Fine coral and volcanic sand	Do.
4139	.....do	512–339	Fine gray sand, rocks	Zoroaster spinulosus.
4141	.....do	437–632	Volcanic sand, foraminifera	Mediaster ornatus.
4146	Vicinity of Bird Island	23– 26	Coarse coral sand, foraminifera.	Mithrodia bradleyi.
4147	.....do	26	Coral, coralline	Mithrodia bradleyi (aberrant).
4149	.....do	33– 71	.....do	Leiaster callipeplus.
4151	.....do	800–313	Fine coral sand, foraminifera, stones.	Tosia micropelta.
4157	.....do	762–1000	White mud, foraminifera, rocks.	Asthenactis papyraceus.
4158	.....do	20– 30	Coral, coralline	Mithrodia bradleyi (aberrant).
4159	.....do	30– 31	Coarse coral sand, broken shells, foraminifera.	Mithrodia bradleyi.
4160	.....do	31– 39	Coral, coralline	Do.
4162	.....do	21– 24	Coral	Do.
4163	.....do	24– 40	.....do	Do.
4164	.....do	40– 56	Coral sand, pebbles, shells	Leiaster callipeplus, Mithrodia bradleyi.
4166	.....do	293–800	Coral sand, foraminifera, rocks.	Henricia pauperrima, Brisinga fragilis.
4168	.....do	20– 21	Coral sand, foraminifera	Astropecten polyacanthus, Luidia hystrix.
4169	.....do	21– 22	Coral	Mithrodia bradleyi.
4170	.....do	26– 27	Coral sand, foraminifera	Do.
4177	Vicinity of Niihau Island	451–319	Gray sand, globigerina	Brisinga panopla, Brisinga alberti.
4178	.....do	319–378	Coral sand, rocks, pebbles	Brisinga panopla.
4186	East of Kauai Island	682–508	Gray sand, foraminifera	Evoplosoma forcipifera.

RELATIONSHIPS OF THE HAWAIIAN STARFISH FAUNA.

The Hawaiian Islands are of peculiar interest to a student of distribution, from the fact that they occupy such an isolated position and because they are surrounded on all sides by very deep water. Since the islands constitute a great mountain range rising from abyssmal depths, the sedentary and sluggish creatures that live at or near the top of this plateau occupy a position somewhat analogous to that of an alpine fauna on an equally isolated mountain range of some continent. Of course the great depths do not afford perfect barriers, since the larvæ of most marine invertebrates are swept about by ocean currents. With reference to the starfishes alone, it would appear that those forms which live at the shore or in very shallow water are slower to change under segregation than the species which dwell at a moderate or considerable depth. Or it may be that the latter is an older fauna, for it is true that every species is peculiar to the region. A number of shallow-water forms also are peculiar,

and I suspect with a good series of specimens for comparison nearly every littoral Hawaiian species would show small but constant differences.

The shore and shallow-water species of starfishes are all tropical forms, and those which are not peculiar to the group are derived from at least two distinct regions. We have first a group of species comprising very wide ranging forms, some of them extending from the Red Sea to China and Japan, and thence to Australia. In this group of ten species all but three occur in the Indian Ocean, and five range into the Red Sea. All extend at least to the eastern archipelago. Most of these forms are characteristic "South Sea" types. The other group comprises but five species and is derived from the coast of Mexico, Central America, and northern South America. The following tables detail these forms.

Species common to the Hawaiian Islands and to the Eastern Archipelago, Indian Ocean, Japan, Polynesia or Australia.

Species.	Locality.
Astropecten polyacanthus	Red Sea, Mauritius, Ceylon, Andaman Island, Port Jackson, Australia, New Zealand, China, Japan, Admiralty and Fiji Islands.
Astropecten velitaris	China Sea, Amboina, Northwest Australia, Admiralty Islands.
Archaster typicus	Eastern Archipelago, Pelew Island, Port Darwin, Port Essington, Cape Grenville, Port Denison, New Caledonia, Fiji, Samoa[a], and Tonga islands, Nicobar Islands, Andaman Islands, Mergui.
Goniodiscides sebæ	Red Sea, Mauritius, Madagascar, Ceylon, Eastern Archipelago, Fiji Islands, New Guinea, Amboina.
Culcita arenosa[b]	Amboina.
Linckia diplax	Mauritius, Madagascar, Isle de Bourbon, Christmas Island, New Caledonia, Fiji and Tonga islands.
Linckia multifora[b]	Red Sea, Mozambique, Mauritius, Ceylon, Larentuka, Celebes, Amboina, New Caledonia, Fiji, and Samoa.
Nardoa ægyptiaca[b]	Red Sea, Mauritius, Bourbon, Samoa and Fiji islands.
Gymnasteria carinifera[b]	Red Sea, Mauritius, Ceylon, Eastern Archipelago, New Caledonia, Fiji Islands, Panama (?).
Valvaster striatus	Mauritius.

[a] Collected in Samoa in 1902 by D. S. Jordan and V. L. Kellogg.
[b] Specimens from the Hawaiian Islands not seen by the writer.

Species common to the Hawaiian Islands and to the west coast of America[a].

Species.	Locality.
Luidia brevispina	Mazatlan, Mexico.
Nidorellia armata	West coast of Mexico, Central America, south to Ecuador and the Galapagos Islands.
Gymnasteria carinifera	Panama (?).
Mithrodia bradleyi	Lower California to Panama.
Heliaster multiradiata	Lower California, Mexico, to Galapagos Islands.

Turning now to the species which are, so far as known, peculiar to the Hawaiian group, both shallow and deep water forms, we find that a number have related species in Japanese and Chinese waters, or in the Eastern Archipelago, as detailed in the following table:

[a] Only in the case of *Mithrodia bradleyi* have these species been directly verified. The Panama record of *Gymnasteria* is very doubtful. Ives records *Archaster typicus* from Mulege Bay, Lower California (Proc. Phil. Acad. Sci., 1889, p. 175). I have doubts concerning the correctness of the label.

Species peculiar to the Hawaiian Islands, which have nearly related species in Japan, China, or in the Eastern Archipelago.

Hawaiian species.	Corresponding species.	Locality.
Luidia hystrix	Luidia aspera	Samboagan and Tablas Island, Philippine group; north of Admiralty Island; 10 to 150 fathoms.
Luidia magnifica	Luidia maculata. [Luidia aspera, also.]	Japan, Manila, Coromandel, Java, Mergui, Ceylon, Mozambique.
Calliderma spectabilis	Calliderma emma	Japan.
Calliaster pedicellaris	Calliaster childreni[a]	Do.
Asterodiscus tuberculosus	Asterodiscus elegans	Philippine Islands; northeast China.
Pentaceros hawaiiensis	Pentaceros orientalis	China.
	Pentaceros troscheli	Billiton.
Benthaster eritimus	Benthaster penicillatus	North of New Guinea.
	Benthaster wyville-thomsoni	North Pacific, between Hawaii and Japan.

[a] Relationship not very close.

Still another set of forms appears to have been derived from the Indian Ocean, or at all events to show a marked resemblance to Indian species. Probably if a direct comparison of specimens could be made, this list would be considerably augmented.

Species peculiar to the Hawaiian Islands which have nearly related species in the Indian Ocean.

Hawaiian species.	Corresponding species.	Locality.
Luidia magnifica	Luidia maculata	Mozambique, Madras, Ceylon, Java, etc., littoral.
Dipsacaster nesiotes	Dipsacaster sladeni	Andaman Sea, 250 fathoms.
Pseudarchaster jordani	Pseudarchaster mozaicus	Indian Ocean, 200 fathoms.
Mediaster ornatus	Mediaster florifer (Alcock)	Andaman Sea, 130 to 250 fathoms.
Antheniaster epixanthus	Antheniaster sarissa	Do.
Ophidiaster lorioli	Ophidiaster robillardi	Mauritius, littoral.
Ophidiaster squameus	Ophidiaster purpureus (?)	Mauritius, Seychelles.
Leiaster callipeplus	Leiaster glaber	Querimba Island, littoral.
Echinaster sp.	Echinaster sladeni	Mauritius, littoral.

Considering these species in conjunction with those actually common to both areas, we are at once struck by the fact that the Hawaiian fauna bears more resemblance to that of the distant Indian region than it does to the fauna of America, notwithstanding that all the ocean currents which pass the Hawaiian Islands are coming from America and not from the west. Ocean currents are almost without doubt responsible for the gradual dispersal of echinoderm species, on account of the pelagic larvæ. It is interesting, therefore, to examine the ocean currents in connection with the apparent relationships of the Hawaiian starfish fauna.

During the southwest monsoon currents set northwest toward the equator in the Indian Ocean from the vicinity of Mauritius and the coast of Africa, thence pass east toward Ceylon, receiving an eastward current from the Gulf of Aden; or, turning more abruptly, flow eastward between the equator and 10° north latitude. These currents, passing the Bay of Bengal, meet a reverse current from the Strait of Malacca, but pass south of Sumatra through Sunda Strait, thence northeast between Borneo and Cochin China past the Philippines and Japan, where the stream is known as the Kuro Siwo. South of the Philippines and north of the Celebes a counter-equatorial current sets eastward in 5° north latitude, passing south of the Caroline and Marshall islands and north of the main, west-flowing, equatorial current. The countercurrent reaches the coast of Central America and is reflected

westward in latitude 10° north, along with a south-flowing current from the coast of North America. The currents which pass the Hawaiian Islands are consequently flowing westward and are derived from the counter-equatorial current and from North America. A branch of the Kuro Siwo sets southeastward from north latitude 35° to 40° toward the Hawaiian Islands, but apparently does not reach them.

During the southeast monsoon the currents are nearly reversed in the Indian Ocean, a stream (42 to 66 knots per 24 hours) setting directly eastward from the Seychelles, south latitude 5°, to the coast of Sumatra, but there is a west current in Sunda Strait and an eastward current along the north coast of Java.

Consequently if we think of the Indian Ocean as the center of dispersal for this fauna, about the only conceivable way in which the species could reach the Hawaiian Islands is by means of the counter equatorial, which is an insignificant stream when compared with the great west flowing equatorial. Yet all the currents setting from America have sufficed to bring only five species and these are by no means cleared of doubt.

Of course there is no a priori reason for considering the Indian the original fauna. The center of dispersal may have been farther eastward. In the case of *Valvaster striatus* it is a long cry from Mauritius to Hawaii, with no intermediate records. The similarity of such a rare type as the *Calliderma* of Japan with that of Hawaii is interesting. The genus, being an old one, is probably widespread, and a number of intermediate forms may remain to be discovered. If the Philippine group and a number of others along the path of the principal ocean currents were as thoroughly worked as the Hawaiian Islands, we would have a far more satisfactory basis for comparison. The *Challenger* made at most but 20 hauls in which starfish were captured, in the Eastern Archipelago, while in the limited area of the Hawaiian Islands the *Albatross* made 123. The results of the *Siboga* expedition may be looked forward to with interest.

Certain Hawaiian species show relationships with Atlantic forms, others with Australian and southern South American species. These are detailed in the following table:

Species peculiar to the Hawaiian Islands and the apparently nearest relatives of those species (other than Indian Ocean and Eastern forms.)

Hawaiian species.	Related species.	South Pacific.	Southern ocean.	Atlantic.
Astropecten ctenophorus	Astropecten pectinatus	Southeast of Australia; Port Philip.		
Psilaster attenuatus	Psilaster acuminatus	East of Australia; west of New Zealand.		Simons Bay, Cape of Good Hope.
Psilasteropsis cingulata	Psilasteropsis patagiatus			Off Cape Verde Islands.
Cheiraster inops	Cheiraster planeta	West of South America (entrance to Straits of Magellan).		
Pseudarchaster myobrachius	Pseudarchaster tessellatus			Simons Bay, Cape of Good Hope.
Pseudarchaster jordani	do			Do.
Tosia ceramoidea	Tosia nitida; Tosia compta			West Indies.
Anseropoda insignis	Anseropoda placenta			Coast of Europe.
Henricia robusta	Cribrella obesa			Falkland Islands, Straits of Magellan.
Henricia pauperrima	Cribrella compacta	Off New Zealand		
Pteraster reticulatus	Pteraster semireticulatus		Off Marion Island.	
Hymenaster pentagonalis	Hymenaster carnosus	West of South America		

A few species stand alone, apparently. I have not been able to find any very close relatives.[a] Such are—

Astropecten pusillulus
Astropecten productus
Ctenophoraster hawaiiensis
Gilbertaster anacanthus
Evoplosoma forcipifera
Ophidiaster sclerodermus
Ophidiaster tenellus
Asthenactis papyraceus (related to Myxaster of Atlantic).

DESCRIPTION OF HAWAIIAN ASTEROIDEA.

SYNOPSIS OF THE FAMILIES.

a. Marginal plates usually large and conspicuous in the adult, defining the contour of body. Papulæ restricted to abactinal area (except in Linckiidæ) circumscribed by the superomarginal plates. Ambulacral plates well spaced and broad. Mouth plates prominent. Actinostomal ring with adambulacral plates prominent. Pedicellariæ when present spiniform, pectinate, valvate, or excavate.

b. Abactinal skeleton composed of true columnar paxillæ or paxilliform plates. Tegumentary developments usually spiniform. Primary apical plates usually not discernible. (See also *bb–c–d.*) Pedicellariæ when present spiniform or pectinate, never bivalved or excavate.

c. Superambulacral plates usually present; if absent, the marginal plates alternate and spiny. (In *dd.*)

d. At least the inferomarginal plates well developed; plates of the 2 marginal series opposite, not regularly alternate.

e. Fasciolar grooves between marginal plates usually well developed; paxillæ typical; median radial paxillæ smaller than those along sides of area. Anal aperture small or wanting (well developed in *Dipsacaster*).

f. Both series of marginal plates present.....ASTROPECTINIDÆ

ff. Superomarginal plates aborted, represented by a series of paxillæ.....LUIDIIDÆ

ee. Fasciolar grooves obsolete; median radial paxillæ larger than those along sides of area; papulæ not extending beyond middle of ray.....PSEUDARCHASTERIDÆ

dd. Plates of the 2 marginal series alternate, usually very spiny. An odd spiniferous interradial plate present in both marginal series in one genus (not Hawaiian). Papulæ confined to limited area at base of ray, often to a special papular organ. Pedicellariæ, when present, pectinate.....BENTHOPECTINIDÆ

cc. Superambulacral plates absent. Medioradial series of paxillæ conspicuously larger than the others. Marginal plates opposite. Spiniform pedicellariæ often present. Superficially astropectinoid.....ARCHASTERIDÆ (restricted)

bb. Abactinal skeleton not composed of true paxillæ or paxilliform plates except in Mediasterinæ, when bivalved or 2-jawed upright pedicellariæ are present. Primary apical plates usually readily discernible. Tegumentary developments usually granuliform, although in the Mediasterinæ the abactinal plates may have well-developed spinelets. In addition to granules the plates may bear specialized spines and tubercles. Pedicellariæ valvate, excavate, or foraminate.

c. Actinal interradial areas large.

d. Abactinal skeleton composed of polygonal or circular (occasionally stellate) plates which may or may not be united by separate internal radiating ossicles. The plates may bear a central tabulum, paxilliform in appearance, or may be simply flat and covered with granules or naked. In some genera the abactinal plates bear a central spine or tubercle, or several. Papulæ usually confined to the abactinal radial areas. The plates may also be obscured by a tough skin which is superficially smooth (Leptogonasterinæ) or covered with granules (Goniodiscidinæ).....GONIASTERIDÆ

[a] One great difficulty is a lack of figures and the poor descriptions of many East Indian forms.

dd. Abactinal skeleton stellato-reticulate, the papulæ usually numerous and in definite areas (except in *Asterodiscus*). Marginal plates sometimes superficially hidden. Abactinal plates often with large conical tubercles.....PENTACEROTIDÆ

ddd. Abactinal skeleton tessellate; the plates often irregular and only partially contingent, the whole covered with a thick, leathery, skin. Flexible. Marginal plates inconspicuous, GYMNASTERIIDÆ

cc. Actinal interradial areas small. Superambulacral plates usually present. Pedicellariæ, when present, excavate. Abactinal skeleton tessellate, arranged irregularly or in more or less regular longitudinal series, with intra- and often infra-marginal papulæ. Rays usually slender, long, and subcylindrical.....LINCKIIDÆ

aa. Marginal plates small and inconspicuous. Papulæ not always confined to area circumscribed by the superomarginal plates, but often present between the marginal plates and on the actinal surface. Ambulacral plates may be crowded or not.

b. Actinostomial ring with adambulacral plates prominent. Ambulacral plates not crowded. Abactinal skeleton composed of thin, close-set overlapping plates, or forming a more or less open reticulate network, either regular or irregular. In one family the abactinal plates are cruciform, with long paxillar spines supporting a supradorsal membrane. Pedicellariæ very rare, never pedunculate or excavate. Tube feet biserial.

c. Mouth plates small, ambulacral groove narrow. Spines not conspicuously long and slender, or supporting a supradorsal membrane.

d. Abactinal skeleton is formed of closely imbricating plates bearing small spines. Actinal skeleton formed of imbricating plates bearing a tuft or fan of spinelets. Marginal plates minute.

e. Papulæ distributed throughout the abactinal area. Abactinal plates thick, crescentiform, devoid of internal processes.....ASTERINIDÆ

ee. Papulæ confined to the radial regions. Abactinal plates in the median regions stellate. Abactinal plates thin, scale-like, with elongate internal prolongations. General form very thin and flat.....ANSEROPODIDÆ

dd. Abactinal skeleton formed of plates disposed in longitudinal and transverse series, or in an irregular network, bearing spinelets; spinelets not disposed in a tuft or fan.

e. Spinelets small, pointed, naked, or covered with a thin skin containing calcareous granulations. (*Valvaster* has large marginal bivalved pedicellariæ).....ECHINASTERIDÆ

ee. Spines heavy, rigid, obtuse, covered with spiniform scales. Reticulation of the dorsum formed of triangles grouped in hexagons.....MITHRODIIDÆ

cc. Mouth plates conspicuously large, plowshare-shaped, with conspicuous marginal and actinal spines. Marginal plates not visible. Abactinal plates cruciform as a rule, bearing a fascicle of rather long delicate spinelets united by a fold of the integument, or supporting a supradorsal membrane which roofs a specialized nidamental cavity.

d. No supradorsal membrane. Spines united by a web. Rays more than 5.....MYXASTERIDÆ

dd. A supradorsal membrane present.....PTERASTERIDÆ

bb. Pedicellariæ pedunculate, either forficiform or forcipiform (composed of 2 jaws and a basal piece). Skeletal plates bearing spines, often long and isolated, on or about which are usually grouped the pedicellariæ; or the pedicellariæ may be isolated. Marginal plates inconspicuous or aborted. Ambulacral plates often very crowded so that the tube-feet are disposed in 4 series. Abactinal skeleton formed of skeletal arches, independent or bound together by intermediate plates, forming a network with rectangular or very irregular meshes; rarely in mosaic. These skeletal arches correspond to every other, or to every third adambulacral, and are composed of pieces corresponding in the ventral, lateral, and dorsal regions of the body. Mouth plates very inconspicuous as a rule.

c. Tube-feet quadriserial, at least at the base of rays. Actinostome with ambulacral plates prominent.

d. More than 25 arms; interbrachial septa double.....HELIASTERIDÆ

dd. Less than 15 arms (Hawaiian species, 5-armed); interbrachial septa single.

e. Adambulacral plates of 2 kinds, alternating, one projecting into the furrow, and separating with its spinelets the tube-feet; the other not prominent. They bear several spinelets in a transverse series. Skeleton regular, composed of imbricating plates...ZOROASTERIDÆ

ee. Skeleton reticulated. Adambulacral plates not dimorphic. Adambulacral plates with 1 or 2 spines. Pedicellariæ usually numerous, either in wreaths about the spines, or scattered ..... ASTERIIDÆ

cc. Tube-feet in 2 series throughout the ray. Actinostome with adambulacral plates prominent. Rays numerous, always more than 5, slender, sharply defined from disk, and armed with slender spines which are sheathed in membraneous sacculi bearing many minute crossed (forcipiform), pedicellariæ. Abactinal skeleton confined to disk and base of ray, on the latter often disposed in independent spaced annular ridges or costæ ..... BRISINGIDÆ

Order PHANEROZONIA Sladen, emended.

Family ASTROPECTINIDÆ Gray, 1840.

Astropectinidæ Gray, Synopsis of the Genera and Species of the Class Hypostoma (*Asterias* Linn.) <Ann. N. H., ser. 1, vol. VI, 1840, p. 180.

Key to the Hawaiian genera of Astropectinidæ.

a. Both series of marginal plates well developed, forming a nearly vertical lateral face to ray. Superomarginal plates are not confined to the abactinal surface beyond basal fourth of ray, but form a part of the side wall of ray.

b. Inferomarginal plates separated from adambulacral plates throughout a portion of the ray by a series of small intermediate plates. Fasciolar grooves not well developed.

c. Marginal plates not tumid; intermediate plates extending nearly to tip of ray ..... PSILASTER

cc. Marginal plates strongly tumid; intermediate plates extending only one-third length of ray ..... PSILASTEROPSIS

bb. Inferomarginal plates touching adambulacrals; not separated throughout ray by a row of intermediate plates. Fasciolar grooves specialized, well developed ..... ASTROPECTEN

aa. The 2 series of marginal plates very unequal in size, forming an angulated margin to ray. Upper series much smaller, and usually confined to abactinal surface; lower series extending laterally beyond superior series.

b. Madreporic body not large and hidden by special paxillæ on its surface. Anal aperture very minute or wanting.

c. No well developed series of plates between inferomarginal and adambulacral series throughout ray (rudimentary at base of ray in *dd.*)

d. Size large. Rays long; a lateral series of flat, leaf-like spines bordering ray; superomarginal plates not conspicuously smaller beyond middle of ray ..... ASTROPECTEN

dd. Size small. Oblique series of long seta-like spines on each *tumid* inferomarginal. Superomarginals very much reduced in size on outer half of ray ..... TRITONASTER

cc. A well developed series of actinal intermediate plates between inferomarginals and adambulacrals. Inferomarginal plates broad and short, band-like; their spines many, appressed to ray ..... CTENOPHORASTER

bb. Madreporic body large, hidden by paxillæ. Anal aperture present, conspicuous in *Dipsacaster*. Fasciolar grooves very deep.

c. Gonads disposed in a series along either side of abactinal integument of ray, extending beyond middle; papulæ distributed generally over the paxillar area ..... DIPSACASTER

cc. Gonads confined to interradial regions, not extending far along rays; papulæ confined to the sides of paxillar area; absent from central portion of disk and rays ..... PATAGIASTER

Genus ASTROPECTEN Schulze.

Astropecten C. F. Schulze, Betrachtung der versteinerten Seesterne u. ihrer Theile. Warschau u. Dresden, 1760.

Key to Hawaiian Species of Astropecten.

a. Superomarginal plates with a single series of erect spines.

b. Spines stout, absent from second and sometimes third superomarginal. Spines of inferomarginals very prominent; not delicate, nor in an oblique comb ..... *polyacanthus*

bb. Superomarginal series of spines rather delicate, continuous throughout ray; not absent from second or third plate. Lateral spines slender, 4 in an oblique comb.....*ctenophorus*

aa. Superomarginals devoid of a series of erect spines; sometimes a single spine on first superomarginal.

b. Size small; no leaf-like lateral spines. Actinal interradial areas small; superambulacral plates well developed.

c. Size small; no leaf-like lateral spines.

d. A single erect spine on first superomarginal plate; and a series of inconspicuous tubercles on plates of outer two-thirds of ray; the tubercles sometimes absent.....*velitaris.*

dd. No spines whatever on superomarginal plates. Rays slender, flexible.....*pusillulus*

cc. Size large; rays very long; a lateral series of large flat leaf-like spines. First 2 or 3 superomarginals with a conspicuous, erect, spinule .....*productus*

bb. Actinal interradial areas well-developed, paved with imbricating plates bearing spinelets in a paxilliform group; superambulacral plates present, but rudimentary in distal half of ray. No superomarginal spines.....*callistus*

Astropecten polyacanthus Müller and Troschel.

Pl. I, fig. 1; pl. II, figs, 1, 1a, 1b.

Astropecten polyacanthus Müller and Troschel, System der Asteriden, 1842, p. 69, taf. v, fig. 3.

Rays 5. R=47 mm.; r=10.5 mm. R=4.3r. Breadth of ray at base, 12 mm.

Arms rigid, very gently tapering to a bluntly pointed extremity. Sides of arms rather high, perpendicular. Disk of medium size. Paxillar surface somewhat inflated. Interbrachial arcs acute but rounded.

Abactinal paxillar area is rather compact, the paxillæ being large and arranged in definite transverse rows, there being about 3 series to each superomarginal plate. Paxillæ are largest in the interradial areas, midway between center and margin of disk, and also along median line of ray. Each paxilla consists of one or two central papilliform granules, surrounded by a radiating series of from 5 to 8 slightly longer ones, the whole crowning a rather long pedicel. On disk the largest paxillæ have upward to 5 central granules of unequal size, surrounded by 10–12 longer marginal ones, and occasionally one of the central granules is enlarged into a cylindrical pointed spinule. Less often one of the marginal spinelets is similarly enlarged (pl. II, fig. 1a), but the two never occur on a single paxilla.

Superomarginal plates, 22 in number from interradial line to extremity of ray, are much higher than broad and do not encroach conspicuously upon paxillar area. They form a rectangular edge to the abactinal surface, and the first plate is raised slightly above the level of the others. Except the second plate, and on one ray the third, each bears a perpendicular, stout, pointed, conical spine situated on the abactinal face, slightly nearer aboral than adoral margin. The spine on first plate is longest and stoutest (as long as the longest spine of any inferomarginal, 4.5 mm.), the series decreasing in length toward tip of ray. The second superomarginal plate, which does not bear a spine, is smaller than either the first or third and is crowded by them. Plates are covered with small cylindrical papilliform spinelets, which become stouter and squamiform toward base of spines. Wide fasciolar grooves between the plates (i. e., between the specialized, elevated, exposed surfaces).

The inferomarginals, which are broader than high, correspond to superomarginals in number and do not extend beyond them laterally. Each plate bears a transverse series of 3 stout and relatively long, tapering, slightly flattened, sharp-pointed spines, the upper longest; to which is added a fourth spinule at inner end of series on third to seventh plates. First 2 plates usually have only 2 shorter, widely spaced spines. Plates are covered with slender papilliform spinelets in the fasciolar grooves and at upper end, these becoming longer, strongly flattened, and bluntly rounded or chisel-shaped at tip, in the vicinity of spines, and on actinal surface generally.

Adambulacral armature is in 3 series. The furrow series consists of 3 long, stout spinelets, the median longest, blunt, somewhat triangular in cross section at its base, the lateral spinelets flattened and truncate. Second series consists of 2 stouter, much flattened, truncate spinelets, the one nearest aboral margin being the larger. Third series consists of 3 blunt, flattened spinelets somewhat smaller than the furrow series, the median being usually slightly the longest of the 3 and most flattened. There is an odd spine, smaller and pointed, situated behind the third series. In all there are usually 9 spines on each adambulacral plate.

Actinal interradial areas are much reduced and are paved each with 4 small roundish plates, which bear spinelets very similar to those covering adjacent inferomarginals.

Mouth plates are prominent, the armature, unfortunately, having been largely destroyed. The marginal spinelets are rather slender, slightly flattened, the innermost 2 or 3 of each plate forming at each mouth angle a horizontal fan of 4 to 6 teeth, of which the median are longest.

Tube feet large, with an incipient conical sucker at end, easily distinguishable from the rest of the foot.

Madreporic body is not visible superficially; hidden by the paxillæ.

Color in life: Paxillar area of distal half of arms vinaceous cinnamon; remainder of arms, and disk, fawn color. The dorsal integument, largely hidden by the regular and ornate paxillæ, is bright vermilion, the color being visible between the spinelets of the paxillæ. Spines of superomarginal plates, orange buff. Marginal plates, inferomarginal spines, and entire actinal surface, light buff pink. Color in alcohol bleached yellowish.

Locality: Station 4168, vicinity of Bird Island, 20 fathoms, coral, shells, and foraminifera. Bottom rough.

Only a single specimen of this handsome species was secured, and that unfortunately, is not perfect. I have felt some misgivings in referring it to *polyacanthus*, having been obliged to depend wholly on the original description. In proportions the specimen agrees most nearly with Müller and Troschel's description of *armatus* (System der Asteriden, p. 71), from Japan, which Sladen and others consider the same as *polyacanthus*, the type of which came from the Red Sea. The descriptions of these two species certainly differ in many points, and presumably the types do also, but in view of the opinion of Sladen and Perrier I have accepted the present name. I have given a full description, with figures, that there may be no mistaking the particular form referred to, whether the name be correct or not.

This species may be readily distinguished from others of the genus inhabiting Hawaiian waters by the row of erect superomarginal spines, the second and sometimes the third superomarginal lacking the spine; and by the stout spines of the inferomarginals, arranged on each plate in a series of three or four.

Astropecten polyacanthus has a wide distribution, extending from the Red Sea to Zanzibar, Ceylon, Hongkong, the coasts of China and Japan (Kobe, Yokohama), New Holland, Admiralty Islands, Fiji Islands, and Port Jackson, Australia. It is a shallow-water species exclusively, ranging from 2 to 50 fathoms, the usual depths at which it is found being 25 fathoms and under. The station at Bird Island is the most eastern record for the Pacific, very materially extending the known range of the species.

Astropecten velitaris Von Martens.

Pl. I, fig. 2; pl. II, figs. 2, 2a.

Astropecten velitaris Von Martens, Archiv f. Naturgesch., Berlin, jahrg. XXXI, bd. I, 1865, p. 360.

Rays 5. R=25.5 mm.; r=7 mm. R=3.6r. Breadth of ray at base, 8.5 mm.

Rays stout, very gently tapering to a blunt point. Interbrachial arcs open, forming a nearly right angle. Disk of medium size. Epiproctal prominence present. Disk slightly swollen.

Abactinal paxillar area compact, the paxillæ being arranged in transverse rows on the rays. Paxillæ consist of 1 or 2 central rounded clavate spinelets or elongated granules, surrounded by 8 to 11 similar ones, arranged in a rosette. Papilliform granules of the peripheral series are not always equal in size on the same paxilla, 2 or more being slenderer than the others. Paxillæ become much smaller at the end of rays.

Superomarginal plates, 17 in number from interradial line to tip of ray, are massive, about as high as broad, and encroach conspicuously upon abactinal paxillar area, forming a rounded margin to ray. The first plate bears a short, erect, rather slender, tapering, sharp-pointed spinule. Plates are covered with small papilliform granular spinelets, capillary in the fasciolar grooves, becoming squamiform on the exposed surface of plates. The fifth to seventeenth plates each bear a short stubby conical tubercle or enlarged granule on the angle between the lateral and dorsal superficies of the plate. The second to fourth plates, inclusive, do not bear these.

Inferomarginal plates form an arched bevel to actinal surface and extend very slightly beyond superomarginals, laterally. Each plate bears an oblique row of 2 sharp, slender, often slightly curved,

somewhat flattened spines, placed at upper end of plate. The upper spine is longer, and the 2 form a double, lateral, longitudinal series to ray. Below the innermost spine along aboral margin of plate are 3 spinules, the upper placed close to the lower lateral spine and the others widely spaced. The first plate lacks the 2 lateral spines, but possesses the 3 lower spinules. A short, odd spinule is often found immediately adoral to the lower lateral spine. The 2 spines and 3 spinules of each plate form a single transverse series. Plates are covered with small, flattened papilliform granules or spinelets, which by reason of their standing out from the plates do not give the impression of being squamiform.

Adambulacral armature consists of a furrow series of 3 long, slender, somewhat flattened spinelets, of which the median is much the longest; and on actinal surface, a group of 3 flattened, round-tipped or truncate spinelets, placed in a more or less regular longitudinal series. Of the latter, 2 are slender, while the third, near aboral margin, is larger and flatter. Near base of ray the actinal group may have as many as 6 spinelets, placed usually in 3 rows of 2 each (due to a shortening of the plate), but one spinelet is always conspicuously the largest.

Armature of the ovoid mouth plates consists of a marginal series of 10 or 11 slender, obtuse spinelets, which increase in length toward inner angle, where 2 are enlarged (the innermost longest), forming, with those of the companion plate, a horizontal fan-shaped series of slightly flattened blunt teeth. The marginal series extends a little more than halfway to outer end of plate, and its spinelets usually stand out over furrow. The superficial series consists of about 10 similar, usually blunter, spinelets, arranged along suture margin, so that a conspicuous, unarmed furrow is left on inner half of plate, between it and the marginal series, and on the outer half between superficial series and first adambulacral plate.

Actinal interradial areas small, there being but 4 small intermediate plates bearing a group of delicate and slender spinelets.

Madreporic body obscured by paxillæ.

Color in life: abactinal paxillar area reddish sepia, becoming burnt sienna toward tips of rays. Marginal plates pale yellowish-brown edged with darker; lateral spines whitish. Actinal surface whitish.

Young: From the presence of an epiproctal elevation on all the specimens I seriously doubt their being fully adult. There is a small example with a major radius of 9 mm., which lacks entirely the spine on each first superomarginal plate, and also the tubercle on the outer superomarginals. The lateral spines of the inferomarginals are small, and there is no trace of the 3 aboral spinules. A very prominent epiproctal cone is present.

Variations: A larger specimen (R=21 mm.) from Penguin Bank has much less massive marginal plates than the example from Hilo Bay used in the above diagnosis, but the armature is essentially the same.

Locality: Station 3849, between Molokai and Lanai Islands, 73–43 fathoms, coarse sand, broken shell, coral; 1 specimen. Station 4031, Penguin Bank, south coast of Oahu Island, 27 fathoms, fine coral sand, coral, and foraminifera; 2 specimens. Station 4055, Hilo Bay, Hawaii, 50 fathoms, fine gray sand and foraminifera; 1 specimen.

This form is readily distinguished from the preceding by the single erect spine on the first superomarginal plate. The species is as near to *velitaris* as to any described form, although the small tubercles on the outer superomarginals are not typical.

Astropecten ctenophorus, new species.

Pl. I, figs. 4, 5; pl. II, figs. 3, 3a–d.

There is a small *Astropecten*, dredged in 130 fathoms, near Laysan Island, which belongs near *Astropecten pectinatus* Sladen, from Australian waters (Port Jackson, off the entrance to Port Philip, East Moncœur Island, Bass Strait, in 6 to 40 fathoms). It differs from this species, however, in several well-marked characters, which can not be accounted for because of a difference in size. I would hardly feel justified in bestowing a name upon such a small specimen, did it not belong to a small section of the genus—that division characterized by having a small spine on every superomarginal, and a lateral, oblique comb of 3 to 5 spines on each inferomarginal.

Rays 5. R=12 mm.; r=4 mm. R=3 r. Breadth of ray at base, 4.5 mm.

Rays are fairly broad at base, tapering continuously to extremity, which is sharp. Interbrachial arcs subacute, very slightly rounded. Abactinal paxillar area plane; no epiproctal protuberance.

Paxillæ of abactinal surface are large and uniform on arms, but of various sizes on disk, where the largest paxillæ occur. Each consists of a very short rounded basal portion, surmounted by a group of 6–16 relatively long, slender spinelets, which radiate from the pedicel top. Of these 1 to 3 or 4 are usually central, the remainder forming an irregular series about them. Usually the spinelets form a widely radiating group, the central ones being stouter than those about the periphery. Very small paxillæ with only 1 to 4 or 5 spinelets are scattered over disk; and at end of the ray these predominate. Papulæ large, confined to border of paxillar area, there being none on median radial areas of ray, or on central portion of disk.

Superomarginal plates, which are 14 in number from median interradial line to extremity of ray, are about as high as broad in the middle of the ray, higher than broad at the base, and broader than high at the extremity. The plates are set very slightly oblique in relation to the long axis of ray, and each when viewed from above is about as long as broad, except in interbrachial arc, where the plates are narrower. They form a nearly right-angled margin to ray. Each bears on the edge formed by the lateral and dorsal superficies a small cylindrical spinule, placed nearer aboral margin than center. Those on first 2 superomarginals are not larger than others. The plates are beset with rather widely spaced, slender, papilliform spinelets.

Inferomarginal plates are broader than high, and do not extend laterally beyond the superior series. Each plate bears an oblique comb of 3 or 4 lateral, delicate, cylindrical, tapering spines, the line of the base forming an angle of about 45° with the transverse axis of the plate and tending from the upper adoral corner downward and aborally. The adoral is the smallest, and most laterally situated. The third from this is the longest; the second is intermediate in size, and the fourth is usually slightly longer than second and nearly as long as third, but on outer half of ray may be much shorter than either second or third. Basalmost inferomarginal bears but 2 or 3 spines. A small spinule is sometimes present on the aboral side of the plate a little distance from the comb. Surface of inferomarginal plates is covered with delicate, slender, papilliform, subcapillary spinelets, which show no tendency to become squamiform.

Armature of adambulacral plates consists of (1) a furrow series of 3 spinelets and (2) a group of 8 or 10 actinal spinelets arranged in either 2 or 3 irregular longitudinal series. Furrow spinelets long and slender, bluntly pointed, the median spinelet longest, and at the base somewhat flattened (in axis crosswise to furrow). They usually stand perpendicularly to plate. On outer half of ray the first series of the actinal group consists of 4 long, very slender cylindrical spinelets, standing upright. The one at the aboral end of series stands on the furrow margin, aborad to lateral spinelet of furrow series, so that the latter appears often to consist of 4 spinelets. On these plates the second actinal series also consists of 4 spinelets, shorter and slenderer, which, by reason of the obliquity of the plate, extend further aborally than the furrow series. Toward base of ray there are usually 3 series of actinal spinelets, very irregular in arrangement, with 3 spinelets to each series, and an odd spinelet between the furrow and first actinal series. The aboral spinelet of the latter is always situated in line with furrow series. One or 2 small spinelets may be added at outer end of plate.

Actinal intermediate plates, 18 in number to each interradial area, show a tendency to encroach upon base of ray. Actinal interradial areas rather pronounced for an *Astropecten*. Each plate is covered with 5 or 6 very delicate subcapillary spinelets, similar to but smaller than those of actinal surface of adambulacrals.

Mouth plates of moderate size. Their whole surface is covered with small slender cylindrical spinelets disposed in three series—a marginal, a superficial, and an intermediate (pl. II, fig. 3d). The innermost spine of the marginal series is much enlarged, forming with its companion 2 stout, blunt, cylindrical teeth at each mouth angle.

Madreporic body small, with very coarse ridges; situated close to margin.

Color in alcohol, ashy white.

Locality: Station 3937, vicinity of Laysan Island, 130–148 fathoms, white sand and small shells; bottom temp. 63°; 1 specimen, type no. 21143, U. S. National Museum.

This species differs from its nearest relative, *A. pectinatus*, in the following respects: Character of abactinal paxillæ, those of *pectinatus* having more numerous, shorter spinelets; disposition of papulæ; character of spines on inferomarginals; character of adambulacral armature, that of *pectinatus* being

arranged in 3 distinct series of 3 each, the spinelets of the 2 actinal series being flat, rather short, with expanded, roundly truncate tips; armature of mouth plates; size of actinal interradial areas, and number of actinal intermediate plates, these being less numerous in *pectinatus*. The present species may be readily distinguished from other known Hawaiian forms by the presence of an oblique comb of 3 or 4 comparatively short, appressed, close-set spines on the sides of the inferomarginal plates, and by the presence of a small, erect spinule on all the superomarginals.

Astropecten pusillulus, new species.

Pl. I, fig. 3; pl. II, figs. 4, 4a–b.

Rays 5. R=33 mm.; r=6.5 mm. R=5r. Breadth of ray at base (between first and second superomarginals) 6.5 mm.

Rays long, slender, delicate, flexible; tapering from a narrow base to a blunt point. In many specimens the outer half of ray has the sides subparallel, then abruptly tapering at the extremity. Disk small; general form depressed, but abactinal paxillar area inflated both on disk and rays. A slight epiproctal elevation usually present. Actinal surface slightly convex. Interbrachial arcs subacute.

Abactinal integument rather thin and the paxillar area uniform and compact. Paxillæ not arranged in definite order. Each arm is marked off from the disk by a shallow furrow in the interradius, which broadens toward the center of the disk, and insensibly grades into its fellows of the 2 neighboring interradii. In this way a stellate area is often formed in center of disk, due to the greater inflation of radial areas, and characterized by a much more compact arrangement of paxillæ. Paxillæ decrease in size toward median radial line, extremity of ray, and center of disk, the largest being found, therefore, in the interradii, and the lateral portions of the base of rays. Each paxilla consists of a columnar ossicle, flaring at the base, surmounted by a single central spinelet which is surrounded by a peripheral row of 6 to 8 club-shaped, papilliform spinelets, each invested with a rather thick layer of membrane. These spinelets are a trifle longer than the basal portion of the paxilla, and they do not usually radiate a great deal. Smaller paxillæ on the arms have 4, 5, or 6 spinelets in the marginal series, and lack the central spinelet. The calcareous portion of these spinelets is slender and cylindrical, the membranous investment producing the clavate appearance.

Superomarginal plates, 31 in number from interradial line to extremity of ray, are about as broad as long, except on the outer third of ray, where their length exceeds the breadth. First 3 plates are higher than long. They form a conspicuous, slightly rounded bevel to margin of paxillar area, tending to become flattened on the outer half of ray, but almost perpendicular in the interbrachial arcs. For a considerable portion of the outer two-thirds of ray they are nearly uniform in size. All are uniformly covered with papilliform granules or spinelets, much larger than those of paxillæ, clavate or sometimes slightly squamiform in shape, each spinelet invested with a pulpy sheath. No spines on superomarginals. Furrows between plates deep, forming well-developed fasciolar grooves.

Inferomarginals correspond in number to superomarginals, and are placed exactly opposite to them. They are much wider than long, forming an even, rounded bevel to sides of actinal surface. They extend but slightly beyond superior series, are armed with an oblique row of 2, or in largest specimens, 3, short, stout, tapering, sharp-pointed spines, placed near the upper or lateral margin. On the outer half of ray the series is rather nearer the aboral than the adoral margin. When there are 3 spines, the 2 outer, or upper, are of about equal length, and considerably longer than the lowest; when only 2 are present, the third to sixth inferomarginals usually have an extra spinule added to the inner end of the series. On first inferomarginal plate, the spines are more reduced in size, and 2 extra spines are added, while 1 is added to the series on the second and third plates. General surface of plates covered with papilliform "barley-corn" spinelets, similar to but larger than those covering superomarginals.

Adambulacral plates with convex margin to furrow. Armature is arranged in 3 series on inner part of ray, but becomes reduced to 2 on the outer half. Inner or furrow series consists of 3 spinelets which are rather short, the middle one larger than the laterals, and slightly tapering, being flattened to produce a blunt-ended blade with the edge toward furrow. The 2 lateral spinelets are slender and tapering. The 2 spinelets of the second series are associated with the furrow series on the proximal plates in large specimens. Second and third (actinal) series consist of 2 tapering and pointed spinelets

each, but toward the middle of ray the outer series becomes reduced in size, finally to an odd spine which persists on a few plates, and eventually disappears at about the middle of ray. Second series persists to tip. In the majority of specimens, on the inner part of ray the actinal spines are grouped into a very definite pedicellarian apparatus, conical in shape. These may be confined to plates of the basal third of ray, or may extend to the limit of the outer actinal series. Rarely on the outer portion of ray a few of the plates have the furrow and second series loosely grouped into a similar apparatus. On innermost plates bearing the actinal pedicellariæ an odd actinal spinelet is present. Sometimes there are 5 or 6 actinal spinelets instead of 4.

Actinal interradial area almost absent. There are about 4 small intermediate plates, each of which bears a 4-valved pedicellaria, similar to, but slightly smaller than those of the adambulacrals.

Mouth plates rather small, elongate, and narrow, with relatively short armature consisting of a superficial series of 10 stout, short, tapering, pointed spinelets, arranged along the edge of the median suture; subequal, except the 2 or 3 outermost, which are smaller, and the innermost, which forms with that of the adjacent plate a pair of longer, tapering, pointed teeth, directed toward actinostome. The spinelets of the superficial series are often blunt. A marginal series of 5 to 8 shorter, pointed spinelets is placed at a higher level, facing the ambulacral furrow. These are either directed outward into furrow, or are appressed against the base of the innermost spinelets of the superficial series. Considerable variation exists among the specimens in regard to the details of armature, such as the number and shape of spinelets, as well as their relative sizes.

Madreporic body small, partially obscured by paxillæ, and situated a little less than its own diameter distant from the margin. Striations coarse and rather few in number.

Color in life: Paxillar area dull olive brown, the marginal plates dull pinkish yellow, or straw color; actinal surface very pale straw yellow.

Young: The smallest specimen taken (station 4181) has R=7 mm., and r=2.25 mm., and besides having relatively shorter arms than the larger examples, differs in details of ornamentation. The paxillæ lack the central granule, there being about 4 or 5 granules spaced around the margin of pedicel. Inferomarginals have but 2 spines. The furrow series of adambulacrals is relatively more conspicuous than in the adult, and the central spinelet is less different from the 2 lateral ones. On first adambulacral plate there are 4 actinal spinelets, 3 of which form a pedicellaria. On second and third plates there are 3 spinelets each, and beyond this point, only 2. A very prominent epiproctal elevation is present. All stages between this and the adult are represented in the collection.

Locality: Type (no. 21144, U. S. National Museum) from station 4116, northwest coast of Oahu Island, 241–282 fathoms, coral sand and foraminifera; bottom temperature 48.8°. *Astropecten pusillulus* was taken in greatest abundance off the north coast of Maui, in from 220 to 253 fathoms, on gray sand. Nearly 650 specimens have been examined. The following is a complete list of the stations:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
3865	Northeast approach to Pailolo channel between Maui and Molokai islands.	256–283	Fine volcanic sand, and rocks.
3918	South coast of Oahu Island	294–257	White sand and mud.
4044	West coast of Hawaii Island	233–198	Fine gray sand.
4045	....do	199–147	Coral sand foraminifera.
4048	....do	374	Fine gray sand, rocks.
4082	North coast of Maui Island	220–238	Gray sand.
4083	....do	238–253	Do.
4084	....do	253–267	Fine sand.
4085	....do	267–283	Sand, shells.
4096	Northeast approach to Pailolo channel	272–286	Fine gray sand.
4116	Northwest coast of Oahu Island	241–282	Coral sand, foraminifera.
4181?	Vicinity Kauai Island?	811–671?	Probably an error for 4081.
3472	South coast of Oahu Island	295	Fine white sand. (Cruise of 1891.)

The present species is characterized by its small size, slender rays, unarmed superomarginals, and the character of its paxillæ and adambulacral armature. It appears to be very distinct from any described form.

Astropecten productus, new species.

Pl. II, figs. 5, 5a–5f; pl. IV, figs. 1–3.

Rays 5. R=183 mm.; r=19.5 mm. R=9.3 r. Breadth of ray at base, opposite first superomarginal, 23 mm.; opposite fifth superomarginal, 25 mm. Width of ray 1 centimeter from tip, 10 mm. Height of ray at base, 10 mm.

Size large; rays long, rather slender and flat; disk relatively very small, the minor radius being less than the width of ray at base. General form depressed, flat. The rays taper very gently to a blunt extremity, and on the outer portion the sides appear almost parallel when viewed from above. Most of the rays are constricted at the base, so that the widest portion is at the fourth or fifth superomarginal plate. Interbrachial arcs are very acute. Abactinal surface plane; actinal surface convex, with broadly beveled margins.

Abactinal paxillar area is uniform and moderately compact on disk, but often rather open on the rays, since the spinelets of the small paxillæ frequently do not radiate to any extent. In specimens where the paxillæ are all expanded like flowers the general appearance is compact. Paxillæ are arranged in rather regular transverse rows at base of ray, except along the medioradial line. On outer half of ray these regular series are confined to a narrow border adjacent to the superomarginal plates. No regularity on disk. Each paxilla is surrounded by about 6 papulæ in a hexagonal series. The latter are absent from the medioradial line of ray. The paxillæ are largest on disk and at either side of medioradial areas. Each consists of a short cylindrical ossicle, flaring at the base, flat-topped, sometimes elliptical in section, surmounted by a central group of 7 or 8 slender spinelets, which are surrounded by a marginal row, more or less irregular, of from 12 to 16. On outer third of arm paxillæ are smaller, but the spinelets decrease only a trifle in number, the average being about 10 in marginal series and 4 or 5 in the central group. Scattered among these are still smaller paxillæ with 7 or 8 marginal spinelets and only 2 or 3 central ones. The spinelets are two-thirds as long as the supporting pedicel.

Superomarginal plates, about 90 to 92 in number from interradial line to extremity of ray, form a well defined, conspicuous, and uniform border to paxillar area. Except for the first 8 or 10 plates they lie entirely on the abactinal surface. The inferomarginals with their prominent spines form the edge of the ray as they project laterally beyond the superomarginals. In the interbrachial arcs the superomarginals for a short distance form a rounded bevel to the margin. They decrease very gradually in size toward the extremity of ray. The length equals about two-thirds the width. The plates are set obliquely, as to their transverse vertical axis, so that their aboral margin slightly overlaps the adoral of the succeeding plate. The aboral margin is curved, and is armed with a series of 4 (varying to 3, 5, or 6) short, stumpy, sharp, squamiform spinules, evidently modifications of the squamiform spinelets which cover remainder of exposed surface of plate. In the fasciolar grooves between plates the papilliform spinelets are slender, becoming gradually thicker, then flatter, toward the aboral margin. In dried specimens, after the membrane has disappeared, this graduation in size is even more evident, but the spinelets no longer appear papilliform, owing to the absence of an organic investment. On the first 2 superomarginals one of the spinules is enlarged, becoming conical and erect, but it is not conspicuous. Terminal plate fairly conspicuous, bifurcate at base, blunt, grooved on lower surface.

Inferomarginals, which correspond in number to superomarginals, are very wide in proportion to length (3.5 to 4.5 : 1) and form a broad even bevel to the margin of the actinal area. The upper end of each plate extends beyond superomarginals, is strongly tumid, and the series forms the margin of the ray. The inner or lower end of the inferomarginals slightly overlaps the outer end of the adambulacral plates. Armature of each inferomarginal plate consists of numerous spines of various sizes, which may be roughly divided into two series: (1) Along the aboral edge of each plate, extending from the extreme inner to the upper or abactinal tumid end, is a row of from 10 to 14 spines and spinules. The uppermost spine surmounts a slight boss on the abactinal tumid end of the plate and is large, flat, leaf-like, lanceolate-acute, or oblanceolate-acuminate, about 6 to 7 mm. in length, by 1.5 to 2 mm. broad. These blade-like spines are very conspicuous, and form a regular series along the side of the ray, resting with their flat side upward. Following these, on the very edge of the ray, are 2 sharp, slender, slightly flattened spines, the upper usually the longer, being about two-thirds to seven-eighths as long as the heavy lateral spine. Occasionally there are 3 in the

group. In a series below these, extending to the lower (inner) end of plate, are from 7 to 11 spines and spinules similar to the 2 just described except in size. Of these the 2 or 3 following the lateral spines are short, and then come 5 conspicuous, slender, tapering, sharp-pointed spines, increasing in length toward the innermost, which is about 5 mm. long, and is situated at the inner end of plate. Between any two of them there is usually a short spinule, about one-fourth to one-third their length. Occasionally there is an odd spine, set out of line with the above series, toward the median line of the plate. (2) The second series of spines forms a semicircular row about the adoral side of the large flat spine, and the lower (inner) end of the series abuts against the regular aboral series, just below the 2 slender marginal spines which accompany the big one. Two spines of this series are placed in an oblique row between the flat spine and the superomarginal plates. Immediately adoral to the large spine are 1 or 2 short spinules, and then between these and the regular aboral series 5 to 7 slender, very sharp, tapering spines, forming a graduated series which merges into the regular transverse series as described above. All are closely appressed to the base of the flat spine. The abactinal surface of each inferomarginal is covered with papilliform spinelets similar to those investing the superomarginals, while the actinal surface is crowded with stouter, clavate, papilliform spinelets, each sheathed with a thick, pulpy investment. They become slightly larger toward the lower end of the plate.

Adambulacral plates numerous, separated by wide sutures and with an angular margin to furrow. Armature composed as follows: (1) A furrow series of 3 long, slightly tapering, round-tipped or truncate-spines, the median of which is longest and stoutest; all are compressed, especially the median, which is saber-like; on the basal portion of the ray usually stand 2 of the actinal spines, one at either end of the furrow series, these, however, shorter and placed behind the lateral furrow spines. (2) Spines of the actinal surface of plate in 3 irregular longitudinal rows of 3 (or 2) each. The median spine of each series is usually flattened and roundly truncate at the tip, the 2 laterals tapering and much smaller. Behind the 3 series of actinal spines are 3 to 6 smaller spinules or spinelets, irregularly placed, on the outer end of the plate. The actinal spines, especially the smaller, are invested with a sheath of pulpy membrane, which greatly increases their thickness. On a dried specimen these same spines are slender, cylindrical or slightly compressed, and exceedingly fragile.

Actinal intermediate plates, few in number (8 to 10), are very small and confined to the inconspicuous interradial area, which does not extend beyond first inferomarginal. The interradial area forms a triangle the sides of which do not exceed 5 mm. The plates are covered with spinelets similar to those of the inferomarginals.

Mouth plates are narrow and not prominent actinally. Armature consists of a marginal series of stout, flattened, blunt spines, 4 of which are arranged in a graduated series on the inner end of the plate, the 2 nearest median suture being largest, and the combined series of the 2 companion plates form a horizontal fan-shaped series. The marginal series, reduced in size, is continued for a short distance along the edge of the plate adjacent to first adambulacral. On actinal surface a superficial series of blunt or pointed, flattened spines extends from end to end of plate along the median sutural margin. Between this and marginal series is an intermediate row of 8 or 10 spines which extend about two-thirds the distance to outer end of plate and are graduated in length, the longest being innermost.

Madreporic body of medium size, situated nearly midway between the margin and center of disk. Striations not conspicuous.

Color in life from immature specimens: Abactinal paxillar area deep vinaceous cinnamon (except paxillæ crowns, which are lighter pinkish buff), shading to cinnamon at tips of arms. Marginal plates buff; large flat marginal spines rose pink. Actinal surface whitish. Color in alcohol dull light brown.

Variations: The chief variations in this species are in minor details of spinulation of the actinal surface of inferomarginals and the relative length of the arms. All the arms of a single specimen are not always exactly the same length. If the minor radius be taken as a unit, the rays of the type are 9.5, 9.3, 9.2. Another specimen of about the same size varies as 8.25, 9.5, 9.3, 8.1, 9.5. The average length is always well above 9:1, while one example has an arm as long as 10:1. The armature of the inferomarginal plates is, as a rule, more robust toward the base of the ray, particularly in respect to the actinal series of spines. In some specimens the spines on the basal plates are subequal in length, there being, instead of 5 large spines with small intermediate spinelets, about 7 or 8. Usually, however, the formula already described holds true.

Young: A single half-grown individual (R=85 mm.; r=10 mm.) differs from the fully adult in having slightly shorter arms and more prominent spinules on superomarginals, there being one on

each plate relatively more enlarged than in the adult. The lateral lamelliform spines are slightly narrower, and there are no enlarged spinelets between them and the superomarginal plates. In fact, the whole of the second series of inferomarginal spines is reduced in size and number.

Localities: Type (no. 21145 U. S. National Museum) and 10 specimens from station 4102, Pailolo Channel, between Maui and Molokai islands, 122–132 fathoms, fine gray sand and foraminifera; bottom temperature, 59.7°. One immature specimen from same locality, station 4101, 143–122 fathoms, coral sand, shells, foraminifera.

This remarkable and aberrant *Astropecten* is especially characterized by its large size, long, flat rays, very small disk, and regular longitudinal series of leaf-like marginal spines. It is quite different from any species heretofore described. Owing to the relatively small size of the disk, the species is very fragile at the junction of the arms and disk. Several specimens have a considerable portion of one or two of the arms regenerated.

Astropecten callistus, new species.

Pl. VIII, fig. 3; pl. IX, figs. 4, 4a–4d; pl. XI, fig. 2.

Rays 5. R=55 mm.; r=12.5 mm. R=4.4 r. Breadth of ray at base (between second and third superomarginal), 12 mm.; between fifteenth and sixteenth, 7 mm.

Disk of medium size; rays long, rigid, tapering, narrow, sharp. Interbrachial arcs rounded. General form depressed. Actinal surface subplane, most prominent at mouth angles; abactinal surface subplane to very gently convex; capable of very slight inflation. The rays are characterized by subvertical sides, and they taper most in the basal third, and only very slightly in the outer half, giving a peculiarly attenuate appearance. The terminal plate is large, subcylindrical, and the tip of ray is usually bent upward.

Abactinal paxillar area is compact and well defined to tip of ray, decreasing in width in proportion to ray. Paxillæ are large and close set, largest in interradial areas and at base of ray, conspicuously decreasing in size toward the center of disk, and much more gradually toward tip of arms. Each paxilla consists of a rather low, cylindrical pedicel, nearly flat-topped, surmounted by a central group of spaced granules, stout, round-tipped, and varying in number from 3 to 8, or even 10. The central 3 or 4 are largest. This group is surrounded by a peripheral radiating series of 18 to 20 smaller, slender, clavate spinelets or elongated granules, the whole very regular and elegant in appearance, and much resembling a composite flower. In the largest specimen (R=64 mm.) there are as many as 24 spinelets in the marginal series, and 12 to 15 in the central group. On disk the pedicels are sometimes elliptical in section, and usually so on the radial portions of the rays. The pedicels are expanded into a fairly large, stellate base. These plates, which are close together and which are joined by their lobes, are generally circular or subhexagonal in contour, the processes, about 6 in number, being short, abrupt, and round-tipped. The latter impinge upon neighboring plates, the papulæ passing through the interspaces between them. The papulæ are single, and are disposed generally over the abactinal surface.

Superomarginal plates, about 40 in number from the median interradial line to tip of ray, are rectangular, about as high as broad, except in interbrachial arc, where the plates are confined almost entirely to the side of ray, to which they form a uniformly arched margin. The exposed surface of the plate is very slightly convex along its transverse axis, and with regard to the longitudinal axis the plates form a very even arc. They are devoid of spines, and are covered with rounded, subconical granules, largest at upper end of plate, becoming papilliform in grooves between the exposed surfaces and at lower end. In the largest specimen 1 or 2 of these granules are enlarged on the marginal angle of ray, but they are quite inconspicuous.

The exposed surface of each inferomarginal, like that of superomarginals, is separated from its neighbors by a fasciolar groove, and there is also a conspicuous groove between the upper and lower series, seen when the ray is viewed from the side. On outer third of ray the 2 series of marginal plates do not always exactly correspond, but there is considerable variation in this respect. Inferomarginals encroach scarcely more on the actinal surface than do superomarginals on the abactinal, except in interbrachial arc. They form an arched bevel to the margin of actinal area, and in some specimens extend just a trifle laterally beyond superomarginals. Each plate bears a row of 3, often 4, short, flattened, tapering, pointed spines, disposed along the median transverse line of the plate.

These spines are usually subequal, or the median slightly the longest, but occasionally near base of ray the uppermost spine is hardly half as long as the second. There are often 4, and rarely 5, spines on the first few plates, and the innermost spine is near the inner end of the plate, the others being subequally spaced. On outer portion of ray there is considerable irregularity in the spines, the 2 upper often being placed in a longitudinal or oblique series near together, separated from the inner or third spine. Inferomarginal plates are further covered with small, papilliform spinelets, those on the upper end of the plate similar to granules of adjacent portion of superomarginal. They increase in length toward the inner end of the plate, where they are much larger.

Adambulacral plates with convex margin to furrow. The armature consists of 5 long, flattened, slender, round-tipped spines disposed in a fan-shaped series. The median spine is longest, somewhat saber-shaped, but round-pointed, and the lateral spines, which form a graduated series at either side, present their flat sides to furrow. The lateralmost furrow spines are really the lateral members of the first actinal series of 3, the central spine of which resembles the laterals. On the outer end of plate is a longitudinal series of 3 or 4 usually considerably shorter spines. When there are but 3 the spines average slightly larger. The armature as a whole has an expanded character resembling *Astropecten* in general.

Mouth plates are small but prominent actinally, with a numerous armature regularly arranged. Marginal series consist of 6 flattened spinelets, of which 2 are placed at the inner angle as teeth, and 4 form a graduated series along the edge of the plate toward furrow. Marginal series is continued along the edge of plate adjacent to first adambulacral as a row of numerous, shorter, and much slenderer spinelets. The actinal surface bears a superficial series of about 15 slender, tapering spinelets placed along suture margin and increasing in size toward the teeth. A parallel series of 8 or 9 similar spinelets extends along surface of plate between marginal and superficial series, but this is lacking on the inner third of plate.

Actinal interradial areas are rather small; paved with fairly large, irregular, overlapping plates arranged in more or less regular series extending from inferomarginals to adambulacrals. These intermediate plates extend in a single (longitudinal) series nearly half the length of ray or to fifteenth inferomarginal, but the outer plates are very rudimentary. In the interradial areas the plates may be described as rudely shield-shaped, or oval, with a notched border. There is a prominent keel on the actinal surface of each, extending lengthwise of plate (interradially), and this keel forms a beak at the inner end of each plate, overlapping the outer edge of the adjacent plate. The plates consequently imbricate, and this is more pronounced in the large than in the small specimens. Armature consists of a series of radiating, slender spinelets of different lengths, placed in a peripheral irregular series about the keel. These spinelets are about the size of those covering the inner portion of inferomarginals. There is also a central enlarged, tapering spinule or group of 3 to 6 spinules, all forming a very ornamental paxilla crown on the keel. Those plates adjacent to the adambulacrals have rather larger spinelets than the others, and on ray their armature is arranged in a radiating coordinate group. Usually the marginal spinelets on the outer side of the keel of all the plates are conspicuously the longest. These peripheral spinelets project over rather wide fasciolar furrows, between the carinations of the plates.

Superambulacral plates are present, well developed on basal half of series but rudimentary beyond the middle of ray. Tube feet are conical, without sucking disks. Anal pore present, minute.

Color in life nearly white, except the tips of the rays and a small area in the interbrachial arc on abactinal surface, which are carmine to bright vermilion or orange vermilion. The interbrachial area is triangular or crescent-shaped and the central portions of the paxillæ are uncolored. In alcohol all the red disappears.

Variations: The variations are all of a minor character and are mostly due to age. Aside from this, however, some difference is apparent among the specimens in the relative width of the interbrachial arc and consequent tenuity of arms, but this seems due to the degree of inflation of the paxillar area. There is one specimen with 6 rays.

Young: The smallest specimen (R = 5 mm., r = 3 mm.), from the stomach of an adult, is quite different in general shape, the disk being large and the rays short and broad. Actinal intermediate areas are already prominent and the spinelets of actinal and granules of abactinal paxillæ fewer in number. Mouth plates have but 2 series of spinelets, marginal and superficial; no inferomarginal spines. Adambulacral armature much as in adult. Most of the stages intermediate between this and the adult are represented.

Localities: Type (no. 21146, U. S. National Museum) from station 4079, north coast of Maui, 143–178 fathoms, gray sand and foraminifera; bottom temperature 60.8°. Taken also at the following stations:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3810	South coast of Oahu Island	211–53	Fine coral sand.
3835	South coast of Molokai Island	169–182	Fine brown sand and mud.
3957	Vicinity of Laysan Island	220–173	Fine white sand.
4044	West coast of Hawaii Island	233–198	Fine gray sand.
4045	do	198–147	Coral sand, foraminifera.
4079	North coast of Maui Island	143–178	Gray sand, foraminifera.
4080	do	178–202	Do.
4114	Northwest coast of Oahu Island	154–195	Coral sand.

This species is distributed, therefore, from Laysan to Hawaii, and its vertical range varies from 169 to 233 fathoms (31 specimens).

Young ophiurans, and a young of the same species were found in the stomach of this starfish.

This species is very abnormal *Astropecten*, if indeed it belongs in that genus at all. The actinal interradial areas are well developed and are paved with strongly imbricating plates, while the inferomarginals are relatively narrow for the genus. The general habit recalls *Tethyaster subinermis* of the Mediterranean region, although the disk is smaller. The superambulacral plates are less well developed than in typical *Astropecten*, and the plates forming the bases of the paxillæ are lobed. An anal aperture is present. This, however, has been found in *Astropecten americanus* by Verrill. *Astropecten mesactus* Sladen has fairly large interradial areas, but differs considerably from this species in proportions and details of structure.

Prof. Verrill has examined a specimen and believes it to be an *Astropecten*.

Genus CTENOPHORASTER, new.

Type *Ctenophoraster hawaiiensis*, new species.

Size large. Disk relatively very small. Rays long, narrow at base, and tapering to a blunt extremity. General form depressed, flattened.

Marginal plates of both series with well-developed ridges separated by deep, narrow, fasciolar channels. Superomarginal plates devoid of spines or any enlarged spinules or tubercles. They are much wider than high (except for a short distance in interradial arc) and are flattened, being confined almost entirely to the abactinal surface. Inferomarginals are very wide, extending laterally beyond superomarginals, armed with 3 oblique lateral series of numerous close-set, slender spines, which are continued toward the inner end of plate as a double series.

Abactinal area with large paxillæ, the pedicels of which are stout, cylindrical, and close-set, their bases flaring slightly to form roundish plates. Integument tough.

Actinal interradial areas fairly large, considering the reduced size of the disk, paved with round plates, which extend as a single series between inferomarginals and adambulacrals nearly to tip of ray (fifteen-sixteenths of total length). They are armed with a diverging group of numerous stout, blunt, tapering spinelets, and on disk each plate bears an enlarged, slender, central spinule surrounded by 2 to 5 shorter ones, the periphery of the tumid plate being adorned with a single series of numerous papilliform spinelets.

Armature of adambulacral plates consists of a furrow series of 4 or 5 spines, followed by 3 series of 3 or 4 spines each, on actinal surface. All are stout but slender, the furrow series being slightly flattened.

Well-developed and stout superambulacral plates are present. Ambulacral furrow narrow, deep, with almost perpendicular sides, the margin being slightly overhung by the adambulacrals.

Madreporic body small, situated rather nearer margin than midway between it and center of disk.

This genus is next to *Astropecten*, from which it differs in having a single series of small intermediate plates interposed between the adambulacrals and the inferomarginal plates. Its long rays,

generally flattened form, very small disk, and the low, broad superomarginals confined almost entirely to the abactinal surface give the form a different facies from *Astropecten*. The broad, band-like inferomarginals and the adambulacrals are much like *Astropecten*, although the armature of the former is very different from any species with which I am acquainted.

Ctenophoraster hawaiiensis, new species.

Pl. III, figs. 1, 1a–1e; pl. V, figs. 1, 2; pl. VI, figs. 1, 2.

Rays 5. R = 150 mm.; r = 22 mm.; R = 6.8 r. Breadth of ray at base (between third and fourth superomarginals) 27 mm; dorso-ventral dimension of ray at base 10 mm.

Rays long and moderately slender, very gently tapering from a narrow base to a blunt extremity. Disk small. General form decidedly flattened, the sides of arms being low and rounded. Abactinal surface plane; actinal surface gently convex, with a very broad even bevel to the sides. Interbrachial arcs acutely rounded.

Abactinal paxillar area is compact, the large paxillæ being arranged in regular transverse rows along the marginal portion of the area, these series becoming interradial in the interbrachial arc. Along median radial line of ray the paxillæ are smaller, crowded, and not arranged regularly, so that a very distinct narrow area is seen running from tip of ray nearly to disk. Paxillæ are more compact in the center of disk than at sides. The largest paxillæ are found in the interradial areas near, but not precisely at, the center of disk, while the largest on the rays are about midway between the median radial line and margin. Each paxilla consists of a stout conical pedicel, flaring at base and summit, surmounted by a variable number of much shorter papilliform spinelets, either united into a compact group, or with marginal series radiating. The larger paxillæ have 20 to 28 spinelets in a central group, surrounded by the same number in a marginal series. A typical large paxilla of the arm possesses about 15 or 16 spinelets in a peripheral series, and 12 to 14 in central group; one from the median radial line, 8 to 10 in peripheral series, and 3 to 5 in the central group. Papulæ numerous, large except along median radial line, where they are small.

Superomarginal plates, 60 in number from the interradial line to extremity of ray, are much wider than high, except in interbrachial arc, and encroach conspicuously upon paxillar area, forming a rather flat border. Inferomarginals extend beyond superomarginals, and define margin of ray. The latter are wider than long, especially the first 3 plates, which are only about half as long as the others and form a perpendicular or slanting wall to the interbrachial arc. Surface of plate is covered with papilliform granules becoming spinelets in the well-developed fasciolar grooves; no enlarged spines or tubercles are present.

Inferomarginals correspond in number to superomarginals; short (2 mm.) and very wide (10 mm.), appearing as bands, stretching from actinal intermediate series to margin of ray, and forming a broad, slightly rounded bevel to border of actinal area. Upper or outer end of each plate extends laterally beyond the superomarginals, and is tumid for the reception of spines. Armature consists of many slender spines and spinules, with still smaller spinelets, grouped into 3 (rarely 4) obliquely transverse curved rows on the outer end of the plate. These series encroach slightly upon the actinal surface of plate, where they merge into 2 irregular transverse rows along the aboral margin, which are continued to the innermost end of the plate. (See diagram pl. III, fig. 1c.) Of the three outer or lateral series, the first, that situated nearest median line of plate is largest, consisting of 7 or 8 slender, slightly curved, tapering, pointed spines, which are closely pressed to the side of ray and overlie the other 2 series (pl. III, fig. 1a). The upper 3 or 4 spines are on the abactinal surface. The second series is arranged parallel to the first, and consists of 5 to 7 similar but slightly smaller spines, while the third series has only 4 spines, still smaller, and arranged along aboral margin. The 2 longer series of actinal spines are somewhat irregular. That nearest the median line of plate consists of 5 to 7 slender flattened, blunt spines, about the size of those of first series of marginal spines, with which this may be considered continuous. These spines are turned upward or outward, are closely appressed to ray, and usually lie crowded in the furrows between adjacent plates. About the base of each, on the adoral side, is a cluster of spinules, 1 to 4 to each spine. These increase in size toward the inner end of the plate, being about one-third to one-half as long as their adjacent spines. There is usually an odd spine at the inner end of plate, in the median line just adoral to the lowermost spine of the regular series. Both are usually sharp. The second actinal series consists of a number (about 7 or 8) of spinules

irregular as to length and position, scattered along the aboral margin below the inner marginal series. They are wholly covered by the much larger spines of the first series. General surface of plate is covered with papilliform spinelets, crowded, becoming slenderer in the deep fasciolar grooves.

Adambulacral plates, wider than long, have a convex margin to furrow. Armature as follows: (1) A furrow series of 3, with which are associated the lateral spines of the first actinal series, making usually 4 or 5 spines on the margin. The median spine is stoutest, most flattened, the 2 laterals decreasing in length and forming a palmate series. The furrow spines proper are truncate or round-tipped, tapering and compressed, the edge being toward furrow. The median spine reaches quite across the furrow. (2) Actinal surface bears 3 or 4 longitudinal series of tapering spines, decreasing in length toward the outer end of plate. The first, or inner, 2 series have about 3 spines each, while the outer 2 commonly have 4, although there is much irregularity. The spines of the inner 2 series are longest, and are slightly flattened, the broad side to furrow.

Opposite each adambulacral plate is a roundish intermediate plate, with a central raised tabulum, the series of which extends to the 55th inferomarginal or to within 12 mm. of the tip of ray (pl. III, fig. 1.) Actinal interradial areas fairly large, considering the small size of disk, and paved with round plates like those of the rays. There are about 16 of these plates, omitting the series adjacent to the adambulacrals, and they do not extend beyond the second inferomarginal. Intermediate plates of ray are armed with a radiating group of 15 to 18 blunt spinelets, resembling the papilliform spinelets of inferomarginals but larger. Rarely a central spinelet is enlarged. In interradial areas each plate bears a conspicuous, bluntly pointed, tapering spinule, about which are grouped 2 to 5 shorter spinelets. Surrounding these is a peripheral series of numerous, still shorter, papilliform, slender spinelets, radiating to form a rosette, the whole armature surmounting the central tabulum of the plate and forming a very ornamental paxilla-crown. On those intermediate plates adjacent to adambulacrals the armature is the same as on ray, except for the presence of 1 or 2 larger central spinelets.

Mouth plates are rather prominent, bent inward toward actinostome. At the inner angle there are 4 heavy, slightly flattened, blunt spines, placed in a perpendicular comb, the largest nearest mouth, and the series of companion plates are close together, forming a double phalanx at each mouth angle. This series is continued toward outer angle of plate as a row of stout, slightly flattened, blunt spinules, along the margin of suture. They are all much smaller than the inner teeth, and become slenderer and weaker as they approach the outer end of plate. Marginal spinelets small, flattened, rounded or truncate at tips, extending in a perpendicular series along border, subparallel to the 4 "teeth," and appressed to an intermediate row of spinelets. Between marginal and superficial series are 3 parallel intermediate series, the one nearest teeth slightly larger than marginal spinelets. These 3 intermediate series are continued toward the outer end of plate as slender and longer spinules forming a bristling armature to actinal surface. A deep fasciolar groove intervenes between the mouth plates and adjacent adambulacral, and that surface of the former which forms the side wall of groove is covered with minute papilliform spinelets. Superambulacral plates well developed.

Madreporic body small, situated slightly nearer margin than midway between it and the center of disk. Ridges are rather coarse, having alternate swellings and constrictions, and cross the plate interradially in direction.

Color in life unknown; in alcohol dull brown.

Locality: Station 3935, vicinity of Laysan Island, 57 fathoms, white sand, broken shells, coralline; bottom temperature 71.1°. Type no. 21147, U. S. National Museum.

This species may be distinguished by its long rays and generally flattened form, by the unarmed superomarginal plates confined almost entirely to the abactinal surface; by the broad, band-like inferomarginals with their numerous small spines; and especially by the series of intermediate plates between the adambulacrals and inferomarginals. The species has the general facies of a flat, long-rayed *Astropecten*, with acutely angular yet rounded margin to rays. It is sufficiently unlike *Astropecten*, in the presence of a series of actinal intermediate plates on the ray and in the character of inferomarginal armature, to warrant its segregation from that much overburdened genus.

Genus TRITONASTER, new.

Type *Tritonaster craspedotus*, new species.

General form flat and depressed; disk of medium size; rays 5, moderately long, tapering gradually from a rather broad base to a pointed tip.

Superomarginal plates much smaller than inferomarginals, especially on the outer part of ray; confined chiefly to abactinal surface; first 10 bearing weak spinules on the abactinal (=inner) edge. Inferomarginals very tumid, each bearing a transverse comb of 4 to 7 long, slightly curved seta-like spines, and, except in interbrachial arcs, defining ambitus. Fasciolar groove at bottom of each broad sulcus between 2 inferomarginal plates, or rather between the summits of their tumid portion, shallow, not specialized, packed with minute spinelets. Covering of marginal plates delicate papilliform spinelets, giving a velvety texture.

Abactinal integument thin, capable of being inflated; covered with small paxillæ which are arranged in regular rows at sides of arms and disk. Those of the median radial portion of arms and center of disk without regular arrangement, and smaller and not uniform as to size. Bases of paxillæ, or abactinal plates, are of different sizes, roundish, and spaced. Papular pores conspicuous, arranged irregularly about the plates, and in 2 series between the lateral abactinal rows of paxillæ, to which region they are confined on the outer half of ray. Actinal interradial areas small, paved with small, roundish plates, a single series of which extends far along ray, but beyond the fourth inferomarginal these plates are only rudiments attached to edges of marginals. Actinal intermediate plates are covered with a compact group of delicate spinelets.

Adambulacral plates are massive, with convex or angular margin to furrow. Armature consists of (1) a furrow series of a few stout spinelets flattened and blunt, and (2) on the actinal surface many slender spinelets arranged in 5 or more irregular, longitudinal rows. Usually about 6 of these spinelets are grouped into a pedicellarian apparatus near the inner, aboral corner of the plate. Ambulacral furrow wide, the tube-feet without suckers.

Superambulacral plates present, slender, but well developed.

Mouth plates prominent, with about 3 series of actinal and 1 of marginal spines. Actinostome fairly large.

Madreporic body moderately large, situated about its own diameter from the margin. Striations numerous, irregular, radiating from an eccentric point.

This genus is characterized particularly by the structure and armature of the marginal plates. It is probably nearly related to *Astropecten* but differs from that genus in the peculiar, very tumid, inferomarginal plates and the reduced superomarginals, which, on the outer part of the ray, are almost abortive. The fascioles are much reduced in size and are quite unlike those of *Astropecten*. Indeed, the structure of the inferomarginals reminds one more of *Persephonaster*, to which the abactinal integument also is similar. Young of *Tritonaster* resembles *Astropecten* superficially, as might be expected, but the peculiar characters are greatly intensified in the adult. The presence of a series of rudimentary actinal intermediate plates, between the adambulacrals and inferomarginals (really attached to the actinal edge of the latter), is, I believe, also a character of generic importance.

Tritonaster craspedotus, new species.

Pl. VIII, fig. 4; pl. IX, figs. 1, 1a–k; pl. XI, fig. 1.

Rays 5. R=61 mm; r=12 mm. R=5 r. Breadth of ray at base, between first and second superomarginals, 13.5 mm.

Rays moderately long, flexible, fragile, tapering continually and gradually from base to a sharp point. Interbrachial arcs acute but rounded. Disk rather small. General form depressed and flat, the marginal plates forming a beveled edge to ray, except in interbrachial arcs, where the sides are perpendicular. Abactinal area subplane, thin, capable of being inflated or depressed. In some specimens it is often so depressed that the inner ends of the ambulacral ridges form 5 humps on disk. Actinal area is plane. Ambulacral furrow takes up about a third the width of ray. Tube feet in 2 rows, conical, without sucking disks.

Abactinal paxillar area is not very uniform in character except at sides of area, where the paxillæ are arranged in regular transverse rows and are uniform as to size; nor is the area at all compact.

Along median radial area of ray and central portion of disk, paxillæ are not regularly arranged nor uniform in size. Paxillæ are small, smallest in central portion of disk, and are widely spaced, giving considerable flexibility to the dorsal integument. The paxillæ of the regular series are rather close together but the rows themselves are separated by nearly twice the diameter of a paxilla. The paxillæ consist of a short pedicel or tabulum surmounted by from 4 to 20 very delicate, subequal spinelets, either coordinated into a compact group, or with outer spinelets diverging. Scattered in among the larger paxillæ are many small, intermediate ones, with from 4 to 10, usually coordinated, spinelets. The diversity in size of paxillæ give to this species a very characteristic appearance. Papular pores are fairly large and numerous, and surround the paxillæ in a series of 4 or 5; arranged in regular double rows between the lateral regular series of paxillæ; not numerous toward tip of rays.

Superomarginal plates, about 28 in number from interradial line to tip of ray, are very much smaller than inferomarginals, except the first 4 or 5 in interbrachial arc, which are only slightly smaller. They decrease rapidly in size toward tip of ray, much more rapidly than inferomarginals, the latter with their armature of long delicate spines forming the border of ray. In interbrachial arc the height (or width) of superomarginals equals length, and by the ninth plate the width has so decreased that it equals only one-half the length. The plates further decrease to mere bands, or ossicles placed end to end, forming an inconspicuous border to the paxillar area (pl. IX, figs. 1 h–j). All are somewhat tumid. Margin of plate toward paxillar area is slightly convex, and owing to tumidity is raised slightly above the level of the area. Plates are covered with tiny, uniform, very delicate, close-set, papilliform spinelets, giving a velvety texture to the surface. Each spinelet is slightly clavate, blunt. Membranous investment is invisible. The first 10 superomarginals each bear a delicate, tapering, sharp spinule on the inner margin, placed rather nearer the aboral than adoral end; those of first 2 plates short, becoming longer on following 4 or 5, then short again. All are very fragile and none are as long as their respective plates.

Inferomarginals correspond to superomarginals in number, and encroach upon actinal surface more than do the superomarginals upon abactinal. Actinal margin of plate is convex, abutting against adambulacrals throughout the greater part of the ray, as the actinal intermediate plates are quite inconspicuous. Plates are set obliquely to long axis of ray; very tumid, the lateral portion being raised into a conspicuous boss, so that when viewed from either above or below the margin of ray appears to be deeply scalloped, the summit of the bosses being fairly acute, the sulcuses between angular. Each boss is surmounted by a comb of remarkably long, slender, delicate, tapering, slightly curved, sharp spines, appressed closely to side of ray, those of outer half of ray extending obliquely over, and resting on, the abactinal area. On first and second inferomarginals the tumidity is not so pronounced as on the rest, and the spines are shorter. On first plate there is a dorso-ventral series of 4, rather widely spaced, the uppermost but one being longest, which when bent upward reaches the middle of superomarginal. Occasionally only 3 short spines are present. On second plate is an oblique series of 3 or 4 spines, exceeding the plate in length, with usually 1 or 2 odd spines set close to and on aboral side of the 2 upper members, and an odd spine on ventral margin. On third plate is an oblique series of 4 (3 to 7) spines, situated nearer upper margin of plate, the lowermost 3 spines being longest (3–5 mm.). From fourth to eighteenth or nineteenth plates the usual number of spines is 6 to each comb (5 in small specimens), varying on some plates to 5 and rarely to 7. Owing to the rapid reduction in the size of the superomarginals, the series of spines moves more and more abactinad, so that on the outer two-thirds of ray the bases of most of the spines can be seen when the specimen is observed directly from above. The longest spine is usually second from bottom of series, and the uppermost is shortest. The spines reach their maximum length about two-thirds the distance from base of ray, where they attain 7 mm. in length (about one-ninth of R), and are fairly long to within 5 or 6 plates of the extremity. General surface of plates is covered with minute papilliform spinelets, similar to those of the superomarginals, but a trifle longer on lower portion of plates.

Adambulacral plates are massive, set obliquely, with an angular margin to furrow; slightly wider than long in basal half of ray; longer than wide in distal half. Armature rather crowded and somewhat variable; in general as follows: (1) A furrow series proper of 3 long, diverging spinelets, the median longest and much flattened, saber-like, the edge to furrow. The lateral spinelets are also somewhat compressed at base. With these are usually associated 2 actinal spinelets, 1 at either end of the series, which are really the lateral members of the first actinal series but on account of the extreme angularity of the furrow margin appear to belong to the furrow group, and toward the extremity of ray the distalmost spinelet of the second actinal series also stands on the furrow margin, making

6 in all. (2) Actinal spinelets of plate, 15 to 30 in number, decrease in length from the furrow toward the marginal plates. There are 3 fairly regular longitudinal series in the inner half of plate. At base of ray the first series has 3 or 4 spinelets, the second 3 to 5, and the third about 4 or 5. On outer portion of ray the spinelets are rather more numerous. Besides these, on the outer half of plate is a variable number of smaller spinelets, not regularly arranged. Many plates have 5 or 6 spinelets, usually on the aboral side, arranged in a definite, conical, pedicellarian apparatus.

Actinal interradial areas are small, paved with small, roundish plates, the series of which, in a rudimentary condition, extend about two-thirds the length of ray (to twelfth or fifteenth inferomarginal). In interradial areas the plates are arranged in series extending from inferomarginals to adambulacrals, and the number of series, with the number of plates in each, is as follows: First inferomarginal, 3 series, 5, 4, and 3 plates, respectively; second inferomarginal, 2 series of 2 plates; third inferomarginal, 2 plates adjoining sixth and seventh adambulacrals. Beyond this point intermediate plates become rudimentary, 1 or 2 being fastened to the lower border of each inferomarginal. Armature consists of long, delicate, slender spinelets disposed in a group similar in all respects to those of adjacent portions of adambulacrals. Spinelets on those plates nearest interbrachial arc are shorter, resembling more nearly the spinelets of adjoining inferomarginals.

Mouth plates are elongate, the united pair ovoid, prominent, broadest toward actinostome. Armature conspicuous and irregular, as follows: (1) A marginal series of about 6 short, blunt, usually somewhat flattened spinelets, which, with those of the companion plate, form a compact, crowded, fan-shaped group at each mouth angle, the angular space between the meeting series being filled with similar spinelets. (2) On actinal surface a superficial series bordering the suture, stout, short, flattened, with rounded, truncate or flaring, leaf-like tips, and narrowing at base; this sort confined to the inner half or two-thirds of plate, the outer portion of series being composed of slenderer, flattened, sharp spinelets. Innermost 2 or 3 spinelets of superficial series are often enlarged to form teeth (*a*, fig. 1 e, pl. IX), which are flattened, oblanceolate, blunt, or truncate. The edge of the plate toward actinostome is angular, like the adambulacral plates, so that the marginal series of 6 or 7 spinelets (*b*, fig. 1 e, pl. IX) is also angulated, and is continued along the border adjacent to the first adambulacral as a series of weaker and smaller spinelets. Between this and the superficial series are 2 more or less irregular rows of similar but larger spinelets placed parallel to the former and increasing in length toward the inner end of plate.

Madreporic body is fairly large, situated about its own diameter distant from margin; striations of medium coarseness, radiating from an eccentric point.

Color in alcohol bleached yellowish to whitish; in life, unknown.

Localities: Type (no. 21148, U. S. National Museum) from station 3918, 8 miles southwest of Honolulu, 294–257 fathoms, white sand and mud; bottom temperature 44.5°. Taken also in this vicinity at station 3914, 289–292 fathoms, gray sand, mud; and at station 3919, 257–220 fathoms, gray sand; 16 specimens taken in this cruise. Cruise of 1891: Station 3473, south coast of Oahu Island, 313 fathoms, fine gray sand; 1 specimen.

This peculiar species was taken only in a very limited area off the south coast of Oahu Island. It is readily distinguishable by its delicate paxillar area, small superomarginal plates, and especially by the remarkably tumid inferomarginals with their armature of long, exceedingly delicate, slightly curved spines.

The stomach contents of several specimens included small gastropods, pteropods, ophiurans, young sea-urchins, ostracod and macruran crustaceans, and small worms in tubes.

Genus PSILASTER Sladen.

Psilaster Sladen in Narr. Challenger Exp., vol. v, 1885, p. 611. Type, *Astropecten andromeda* Müller and Troschel.

Psilaster attenuatus, new species.

Pl. III, fig. 3, 3 a–d; pl. VII, fig. 4; pl. VIII, fig. 1.

Rays 5. R=107 mm.; r=17.5 mm. R=6 r. Breadth of ray at base (between second and third superomarginal plates) 18.5 mm.

Rays elongate for genus, rather narrow, with a relatively narrow base, thence gently tapering to a slender sharp extremity. Interbrachial arcs acute, but sharply rounded. Disk relatively small. Abactinal area plane; actinal area plane; disk capable of slight inflation.

Abactinal paxillar area is rather uniform in character, but not very compact, except in center of disk, the paxillæ being spaced so that the papulæ may be detected between them. The latter are crowded into rows between the regular transverse lines of paxillæ. Along a very narrow median line on each ray, where paxillæ are not regularly placed, the papulæ are wanting, and they appear to be absent also from center of disk. Paxillæ are rather small and decrease slightly in size toward median radial line, extremity of ray, and center of disk. Each paxilla consists of 2, 3, or 4 central papilliform spinelets surrounded by a peripheral series of 7 to 10 similar spinelets. The latter may radiate like the petals of a flower, or the whole form a coordinate group. The more numerous paxillæ possess about 2 central spinelets and 7 to 9 marginal ones, while the largest may have upward to a dozen marginal spinelets. In specimens from off the south coast of Oahu, which differ slightly from the type, the paxillæ are usually more crowded and the spinelets form a coordinate group, giving the abactinal surface a much more compact appearance. In proportion to size of animal the paxillæ of these specimens are a trifle larger than the type, but the number of spinelets does not appear to average greater.

Superomarginal plates, 57 in number from the interradial line to extremity of ray (or 60 in largest specimens, with R=120 mm.), form a somewhat rounded bevel to margin of ray. Plates short and high (or wide), the longest being the tenth to fifteenth from the interradial line. Each plate has a specialized ridge, the ridges of consecutive plates being separated by rather narrow transverse fasciolar grooves, for the most part obscured by crowded papilliform spinelets. It is the exposed, very slightly tumid face of these ridges which forms the outer or exposed face of the plates on the dorso-lateral face of the ray. The plates are covered with crowded, short, papilliform spinelets, each of which is invested with a membranous sheath. On the outer two-thirds of the ray (beyond the eleventh or twelfth superomarginal) each plate has 1, 2, or sometimes 3, short, delicate spinules placed in a median transverse row at about the middle of the plate. The spinelets surrounding these are flattened or squamiform. The spinelets lining the sides of the fasciolar grooves are very much slenderer than those of the exposed surface of the plates, the latter being much more crowded about the edges than in the center.

Inferomarginal plates correspond exactly to the superomarginals, and form an abruptly rounded margin to actinal area. When the ray is viewed from side the whole height of supero and infero-marginal plates can be seen. Inferomarginals are considerably higher (or wider) than long, and like the superomarginals possess an especially elevated ridge, the successive ridges (the exposed surface of the plates) being separated by fasciolar grooves filled with papilliform spinelets. Plates are covered with crowded spinelets, similar to those investing the superomarginals, which increase slightly in size toward the actinal intermediate plates. Each plate carries a row of 3 flattened, tapering, sharp spines, directed obliquely upward and toward end of ray. These are placed in a median dorso-ventral line, the middle spine being longest (in length equaling 2 inferomarginal plates, or their exposed surfaces). All 3 are closely appressed to the ray. On outer third of ray there are only 2, the upper spine being absent. On the proximal 2 or 3 inferomarginals there are usually only 1 or 2 spines, reduced in size. A few of the largest specimens possess a series of 4 spines on the more proximal inferomarginals, but the number is usually 3. In the specimens from the south coast of Oahu, already alluded to, the spinelets covering both supero and infero-marginals are more thickly covered with membrane, appear more fleshy, and tend to be more squamiform. Those of the inferomarginal plates are particularly soft. They increase in size actinally, on the lower part of the plate being rather larger than the papillæ of adjacent actinal intermediate plates.

Adambulacral plates massive, about as wide as long, with an angular margin to furrow. The plates are separated by fairly conspicuous sutures, forming shallow grooves usually continuous with the fasciolar grooves between the marginal plates. Adambulacral armature as follows: (1) A furrow series of 7 or 8, occasionally 9, rather long, flattened, blunt spinelets, the central ones being very slightly the shortest. These spinelets are so arranged that about 4 are placed along either side of the angular margin. The median 2 or 3 spinelets are compressed so that the edge is toward the furrow, but the lateral ones present their flattened face thereto. Considerable of the flattening, which is more pronounced at the base of the spinelets, is due to the membranous envelope of each. (2) The remaining spinelets, more or less grouped and 10 to 15 in number, form a rather compact group on the actinal surface. They are tapering, blunt, and are usually disposed in 3 irregular longitudinal rows. These actinal spinelets are often thicker than the marginal series, and are invested with a rather pulpy membranous sheath, which frequently flattens in the outer spinelets of plate (especially in specimens

from off the south coast of Oahu). When the membranous investment is removed from any of the spines they are seen to be delicate, slender, and pointed.

External to each adambulacral plate is a small intermediate plate (or a transverse series of 2, 3, or more), the longitudinal series of which extends along the ray to about the fortieth adambulacral, and thirty-sixth inferomarginal plate. This series is a continuation of the small roundish or elliptical plates covering the actinal interradial area. The number of intermediate plates opposite each adambulacral and extending interradially, or transversely to the corresponding inferomarginal, is as follows: One small unpaired interradial intermediate plate adjacent to outer end of mouth plates; first adambulacral, 4 (the series not reaching as far as inferomarginals); second and third adambulacral, 7 (series meeting first inferomarginal; fourth and fifth, 4 or 5; sixth, 4; seventh to fourteenth, 3; fifteenth to twenty-fourth, 2; twenty-fifth to fortieth, 1. In young specimens these plates are naturally fewer in number. New plates are added adjacent to the inferomarginals. The armature consists of small, blunt papilliform spinelets, grouped or arranged in a double, longitudinal series. They are similar but slightly smaller than adjacent spinelets of the adambulacral plates. All are characterized by a soft membranous investment or sheath.

Mouth or dental plates fairly prominent actinally; narrowly ovoid; rather elongate with a regular armature, consisting of a single line of stout, slightly flattened spinelets with rounded or truncate tips, arranged along margin of plate adjacent to the interradial suture. On outer free margin of plate, placed higher than the first series, is a second series of smaller, truncate, flattened spinelets, closely appressed to the outer side of the superficial series. Innermost spines of the superficial series stouter, longer, and more flattened than the rest, forming at each mouth angle two prominent teeth, with which are also associated two smaller spines of the second series. There is considerable variation in the relative size of these 4 teeth, but the lateral are much smaller and weaker than the median pair. They are usually directed away from the actinostome, appressed against the adjacent spines of their respective series, and are hence very inconspicuous. Space between the superficial series of companion plates fairly wide.

Madreporic body small, situated near margin, about two-thirds the distance from center of disk to inner edge of the superomarginal plates. Striations coarse in adult individuals, beset with scattered tubercular projections; the latter often nearly absent.

Color in life: Abactinal paxiliar areas brick red on the disk, shading into vinaceous rufous on arms, and finally to orange rufous at extremity of arms; superomarginal plates pinkish buff, shading into pink on the actinal surface; tube-feet raw sienna. Young individuals pinkish; marginal plates nearly white. Color in alcohol deep brown to dirty yellowish white; young, bleached yellowish.

Variations: With one exception, most of the variations are of a very minor nature, and can easily be accounted for by the difference of size or age. There is, however, a group of specimens from off Diamond Head on the south coast of Oahu Island which have already been alluded to in the foregoing description; all these specimens are characterized by shorter and thicker rays (as compared with the disk) than those possessed by the type, and the paxillæ seem to be just a trifle larger and are more crowded, giving the paxillar area a more compact appearance; the spinelets of the marginal plates are fleshier and more squamiform. This form can be separated at once from the typical specimens throughout all the stages of growth, as shown in the accompanying figures. (Pl. XLIX, figs. 2 and 3.) None of the thick-rayed form were taken among the 150 specimens from off West Maui and the Pailolo Channel, but two apparently (almost) typical specimens were taken off Diamond Head, in the same general locality as the thick-rayed variety. The latter appears too slightly and insecurely separated from the typical form to warrant a specific name. Neither is it possible to bestow a trinomial designation upon "this well-marked 'variety'" as some recent writers might be willing to do. Until something more definite is known concerning the different phases or variations (often quite constant and occurring in the same locality) which starfishes are known to exhibit, it seems somewhat ill-advised to pervert the trinomial to such uses. These forms can not be considered as subspecies, at least not in the sense in which ornithologists understand the term, for they are not equivalent to geographical races.

Young stages: The young are considerably different in general appearance from the adult. The smallest specimen has R=9 mm., and r=3 mm. The smallest of the thick-rayed variety has R=9 mm., and r=4 mm. The small specimens are therefore characterized by shorter and broader rays than the adult, few marginal plates, relatively large ocular plates, which bear 3 minute spinelets, less compact

paxillar area, fewer spinelets to the paxillæ, only 2 weak spinelets on the inferomarginal plates instead of the series of 3 of adult, no trace of an enlarged spinule on the superomarginals. The spinelets of the paxillæ radiate, forming beautiful rosettes, and are not clustered in a bunch as is usual in large examples. There are 3 to 5 of these spinelets, representing the marginal series of the adult, the central spinelets being absent. The teeth are much more prominent in little specimens. The transition between this and the adult is represented in the collection. The general facies of the adult is reached when the creature has attained a major radius of about 55 mm., at which age there are something over 40 superomarginal plates. The immature specimens all have a low epiproctal hummock or cone, very pronounced in the little examples, but wholly absent in the fully adult forms. As mentioned in the previous paragraph, all the stages of the Oahu specimens have thicker rays than the typical form.

Localities: Type (no. 21149, U. S. National Museum) from station 4095, northeast approach to Pailolo Channel, between Maui and Molokai islands, 290–286 fathoms, brown mud, fine sand, and globigerina; bottom temperature, 43.9° F. As detailed in the following table, the specimens were taken either from the northeast approach to Pailolo Channel (which separates Molokai from Maui) or in practically the same locality farther out, to the north of western Maui; or they were dredged off the southern coast of Oahu, most of the latter being not quite typical. The longitudinal distribution of *Psilaster attenuatus* extends from 256 to 337 fathoms, the most favorable depth for large specimens being in the neighborhood of 290 fathoms. The nature of the bottom varies, specimens having been taken in globigerina ooze and mud, fine volcanic sand and rocks, gray mud and fine sand, sand and shells, fine gray sand, brown mud and fine sand with globigerina.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3865	Northwest approach to Pailolo Channel, between Maui and Molokai islands.	256–283	Fine volcanic sand and rocks.
3866	.....do	283–284	Gray mud, fine sand.
3867	.....do	284–290	Fine sand, mud.
3883	.....do	277–284	Globigerina ooze.
3884	.....do	284–290	Globigerina mud.
3908	South coast of Oahu Island	304–308	Fine white sand and mud.
3909	.....do	308–322	Do.
3910	.....do	311–337	Fine gray sand, mud.
3911	.....do	337–334	Do.
3916	.....do	299–330	Do.
3917	.....do	330–294	Do.
3918	.....do	294–257	White sand, mud.
4086	North coast of Maui Island	283–308	Sand, shells.
4087	.....do	308–306	Fine gray sand.
4088	.....do	306–297	Do.
4089	.....do	297–304	Do.
4090	.....do	304–308	Do.
4091	.....do	308–306	Do.
4095	.....do	290–286	Brown mud, fine sand, globigerina.
4096	Northeast approach to Pailolo channel	272–286	Fine gray sand.

In December, 1891, the *Albatross* made a few dredge hauls off the south coast of Oahu and secured about 60 specimens, the greater number of which are typical. They were taken at stations 3470, 343 fathoms, white sand; 3471, 337 fathoms; 3474, 375 fathoms; 3475, 351 fathoms (four-fifths of the specimens); 3876, 298 fathoms.

This species, of which about 230 specimens have been examined in all stages of growth, is one of the commoner forms of the medium depths. It is characterized by the long graceful rays, and by the form of its paxillæ and the armature of marginal and adambulacral plates. It is most nearly related, among forms already described, to *Psilaster acuminatus* Sladen, which has been taken northwest of Port Hardy, New Zealand, and Simons Bay, Cape of Good Hope. It differs from Sladen's species principally in having longer and slenderer rays, in the covering of the marginal plates, and to a less extent in details of paxillæ and adambulacral armature. The rays of *attenuatus* are even longer relatively than those of *gracilis; gracilis*, however, is widely different from *attenuatus*.

Genus PSILASTEROPSIS, new.

Type *Psilasteropsis cingulata*, new species.

Disk small; rays long, robust, and tapering to a pointed extremity.

Marginal plates massive, conspicuously encroaching on both abactinal and actinal areas; slightly or strongly tumid. Surface of plates covered with squamules, becoming papilliform in groves between. Superomarginal plates devoid of large spines or tubercles; inferomarginals bearing a series of short tapering spines, disposed more or less obliquely and closely appressed to ray.

Abactinal area covered with compact paxillæ, composed of papilliform spinelets grouped in a coordinate bunch on a thick pedicel. Arranged more or less regularly in transverse rows at sides. Abactinal plates (bases of paxillæ) roughly hexagonal, placed rather close together. Papulæ conspicuous, arranged around each plate. They are scarce toward extremity of rays and center of disk.

Actinal interradial areas small, with small intermediate plates which extend only about one-third the length of ray. Intermediate plates all bear groups of papilliform spinelets, which are sometimes grouped to form an incipient pedicellarian apparatus.

Adambulacral plates massive. Armature consists of (1) a furrow series of numerous, rather delicate, subequal, long, uniform spinelets forming a regular, straight-edged comb; (2) on the actinal surface of the plate 2 or 3 irregular longitudinal series of shorter, cylindrical spinelets. These are sometimes grouped to form a conical pedicellarian apparatus on plates near base of rays. Tube feet without sucking disks, large, in 2 rows.

Madreporic plate of medium size, situated rather nearer margin than midway between it and center of disk.

A tiny pore, anal in position, is apparently present. Superambulacral plates present, well-developed.

This genus is erected for the reception of a species which differs in several essential points from true *Psilaster;* namely, in the more massive and distinctly tumid marginal plates, very much reduced fasciolar channels, the more restricted actinal intermediate plates, which do not extend far along the ray, in the regular and more numerous furrow spines of the adambulacral plates, in the large paxillæ which are tabulate, and which give to the abactinal surface a very characteristic appearance. In this genus should be ranked, also, *Psilaster patagiatus* Sladen, which, however, differs from *cingulata* in having incipient excavate pedicellariæ on the superomarginals and in the armature of the mouth plates. The general facies of the two species is much alike. Mr. Sladen, in describing *Psilaster patagiatus*, expressed serious doubts as to the propriety of referring that species to the genus *Psilaster*, and now that a second, similar, well-marked form has been found on the opposite side of the globe, it becomes doubly necessary to segregate the forms.

Psilasteropsis cingulata, new species.

Pl. III, figs. 2, 2 a-b; pl. VII, figs. 1, 2, 3; pl. VIII, fig. 2.

Rays 5. R=95 mm; r=18 mm. R=5 r+. Breadth of ray near base (between second and third superomarginal plates) 18 mm.

Rays long, fairly narrow at the base, gently and gradually tapering to an acute tip. Disk small. General form somewhat flat and depressed. Sides of ray nearly perpendicular. Abactinal surface plane; actinal nearly so. Interbrachial arcs acute but well rounded.

Abactinal paxillar area is depressed slightly below the level of the superomarginal plates and extends to the tip of the arm, but is usually greatly reduced in width on the distal third of the ray, being only about as wide as the furrows between the superomarginals of that region. Width of paxillar area at base of ray (between second and third superomarginals) 12 mm. Paxillæ are larger in the center of ray than on side, but are smaller in center of disk. They are subcircular in outline when regarded from above, short, composed of a short cylindrical basal ossicle surmounted by delicate cylindrical spinelets in a coordinated group. In the larger paxillæ a peripheral circle of 15 to 25 spinelets surrounds an irregular central group of about 15. Instead of flaring, the marginal row usually stands perpendicularly, or inclines inward against the central group, giving the paxillar crown a very compact appearance. Spaces between paxillæ are conspicuous, allowing the small papulæ to be clearly

visible; the latter are arranged irregularly in a circle of 6 or 7 around each paxilla. Along the margin of dorsal area the paxillæ are arranged in definite transverse rows, but no order is distinguishable along the median radial line or in center of disk.

Superomarginal plates, 33 in number (varying from 30 to 37 in different individuals) from the median interradial line to extremity of ray, form a well-defined, broad, and massive border to disk and rays. Each plate is strongly tumid along its transverse axis, so that a broad, rounded well-defined sulcus is formed between successive plates. The extreme tumidity of the marginal plates gives to this species a highly characteristic appearance. The superomarginals are longest (3.5 mm.) toward the base of ray—the third to twelfth plate. Breadth of fifth superomarginal 6 mm. Surface of plates covered with granules and delicate spinelets. Those of the transverse tumid portion are distinctly spaced, flat, roundish, squamiform, but not imbricating, tending to become larger on the abactinal surface; those covering transverse marginal regions of the plate are slender and delicate, giving the appearance of plush. They are longest in the bottom of the groove between the plates, becoming shorter toward the squamiform granules into which they pass insensibly. Under the microscope the latter sort are seen to be cylindrical, slightly swollen at the tips, and invested with a delicate membrane.

Inferomarginal plates correspond exactly to superior series, and they encroach as much upon the actinal surface as do the latter upon the abactinal. They are tumid, the ridge passing obliquely from the middle of the superior margin toward the aboral ventral corner of plate. The upper half of this ridge bears a row of 4 slender, tapering, slightly flattened spines directed obliquely upward and outward and closely appressed to ray. The lowest but one is longest, being about one-third longer than its plate (except on the outer half of ray). These spines decrease in length toward the extremity of the ray, where the series is usually reduced to 3 with an occasional plate bearing 4. The first 5 plates usually bear 5, or sometimes 6 spinules. On the inner third of ray there may be 2 or even 3 short, more widely spaced spinules on the ventral portion of the ridge between the upper series and the ventral margin, situated rather toward the aboral edge of the plate. On the first 2 plates of each ray there is an extra spine or pair of spines on the adoral margin, on a level with the ventral series, the upper spine equalling the length of its plate, and in addition there is an odd spine placed close to, but out of line with, each of the 2 upper spines. General surface of inferomarginals is covered with papilliform spinelets, which become larger, flattened, and squamiform on the median tumid portion of the plate, and more robust toward the ventral margin. They are larger than the spinelets of the superomarginals.

Adambulacral plates large and massive, about 50–54 to the ray, slightly longer than broad, and with a decidedly convex margin to furrow. Armature consists of a furrow series of 11 to 13 long, thin, delicate, laterally-compressed spinelets, standing subparallel or diverging slightly. The outer spinelets are usually slightly the longest, equalling length of plate. Tips of the spinelets form a slightly curved border to the comb. The usual number in the furrow series is 11, decreasing at the tip of ray to 9, or less; covered with delicate membrane. On actinal surface of the plate are 3 irregular longitudinal rows of tapering, membrane-covered, pointed spinelets, there being usually 6 in the first series, 4 or 5 in the second, and 3 to 5 in the third, with often 2 or 3 odd very short spinelets. In basal portion of ray these spinelets are prominent, and are nearly as long as those of the furrow series; they decrease in length and number toward extremity of ray. In the first 3 or 4 plates 5 or 6 actinal spinelets may be grouped to form a pedicellarian apparatus.

Mouth plates are elongate, rather narrow, and prominent actinally, the united pair being elliptical in outline. Their armature is somewhat peculiar, consisting of a marginal series of 9 stout, tapering spinelets shorter than the furrow spinelets of the adambulacrals, the median spinelets of each free margin being the longest of the series. About as many more smaller spinelets are continued along the margin adjacent to the first adambulacral. Along the margin of the median suture is a series of about 16 stout, blunt, flattened spinelets which increase in length toward the inner extremity of the plate, the innermost spine being flattened, long, lanceolate, and directed with its fellow of the companion plate across actinostome. Between the marginal and superficial series is an intermediate series resembling the latter but with fewer spinelets. The peculiarity of the armature is that the intermediate and marginal series, rather closely appressed, continue above (abactinad) the level of the main tooth along the edge of the plate, curving in such a manner as to be directed not toward actinostome, but across the ambulacral furrow. This double series terminates on a level with and just outside the

outer edge of the peristomial membrane. The teeth are consequently a part of the superficial, not of the marginal series. This arrangement bears a striking resemblance to that found in *Psilaster gracilis* Sladen, but in other respects the two species are dissimilar.

Actinal intermediate plates are confined to a small area in the interradial region, and extend along the ray as far as the seventh inferomarginal plate. They are arranged in regular series extending parallel with the interradial line from the inferomarginals to the adambulacrals. Opposite first inferomarginal there are 3 series, abutting against mouth plate and first three adambulacrals; between first and second inferomarginals, 1 series, meeting fourth adambulacral; opposite second inferomarginal, 1 series of 3 plates meeting fifth adambulacral; third inferomarginal, 2 series of 3 and 2 plates meeting sixth and seventh adambulacrals; fourth inferomarginal to seventh, a single longitudinal series of plates, the last 2 being rudiments. Actinal intermediate plates are armed with groups of spinelets shorter but otherwise similar to those of the actinal surface of adjacent adambulacrals. Plates frequently bear a spinule in the center, flattened, sharp, and tapering, which resembles those of the ventral series of the proximal inferomarginal plates. In one specimen these are entirely absent, and the spinelets here tend to group themselves into a pedicellarian apparatus. This is true also of many of the actinal intermediate plates of typical specimens.

Madreporic body small, partially obscured by neighboring paxillæ; coarsely striated. It is situated about 3 times its own diameter from the inner border of the superomarginals, and nearly bisects the minor radius.

Color in life: Abactinal paxillar area light dirty green; rest of arms light flesh pink; tube feet raw sienna. Color in alcohol, bleached yellowish or dirty white, brownish on paxillar area.

Young: In an immature specimen in which R = 21 mm. and r = 6 mm., the superomarginal plates are 13 in number and very massive, almost obliterating the paxillar area of the distal two-thirds of ray. Paxillæ have less numerous spinelets than in the adult, there being about 8 to 10 altogether. Spines of inferomarginal plates of normal number, but shorter than in the adult. Terminal plate with 3 blunt papillæ. Adambulacral spinelets of marginal series 8 or 9, the new spinelets being added at sides; spinelets of actinal surface in 2 rows. Actinal intermediate plates are fewer in number than in adult, the new plates being added next to inferomarginals and growing along ray, extending in this specimen only as far as fifth adambulacral. Mouth plates similar to adult, but with fewer spinelets, the teeth being very prominent. Membranous investment of all spinelets relatively thicker than in adult. Another example (R = 48 mm., r = 9 mm.) is intermediate between the above and adult in nearly all respects except proportions.

Variations: A specimen from station 3887 has rather broader rays than other examples, and the superomarginal plates encroach a trifle less upon the abactinal paxillar area. In another example, from station 4028, the spinules on the actinal intermediate plates are more frequent and longer than in the type. The spines of the inferomarginals are likewise more prominent, there being an additional spine throughout in the superior series; the inferior series extends farther along ray than in normal specimens, and its spinules are more prominent, forming a continuous series with the dorsally placed ones. Still another specimen (station 3995) lacks entirely the usual spines of the actinal intermediate plates, and the spinelets of these plates and of the actinal surface of the adambulacrals are relatively about half as long as those of the type, there being more plates which possess the specially grouped papillæ acting as pedicellariæ. In choosing the type I selected a form which is most representative of the entire series in the totality of its characters.

Measurements of adult specimens of Psilasteropsis cingulata, in millimeters.

Major radius	95	78	80	77	88	81	93	90
Minor radius	18	15	16	15	17	17	18	21
Width of ray between second and third superomarginal plates	18	17	17.5	15.5	17.5	16.5	19	20
Breadth of paxillar area, same place	12	11	12	10	12	10	13.5	16
Number of superomarginal plates	33	30	32	33	33	31	35	30

Localities: Type (no. 21150, U. S. National Museum) from station 3997, off Ukula Point, Kauai Island, 418–429 fathoms, fine gray sand, brown mud; bottom temperature 41°. Taken also at the following stations, 11 specimens in all.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3824	South coast of Molokai Island	222–498	Coral rock, broken shells.
3887	North coast of Molokai Island	552–809	Globigerina mud.
3995	Vicinity of Kauai Island	427–696	Fine gray sand, rocks.
4028	do	444–478	Gray sand, globigerina.
4123	Southwest coast of Oahu Island	352–357	Fine gray sand and mud.

This species is most nearly related to *Psilasteropsis patagiata* (Sladen) from off the Cape Verde Islands, from which it may be distinguished by the following characters: The relatively longer and slenderer arms; more strongly tumid marginal plates; absence of incipient pedicellariæ on superomarginals; larger paxillæ, with more numerous spinelets; relatively narrower paxillar area; details of spinulation of inferomarginals; by the adambulacral armature; armature of the mouth plates, the last character showing a resemblance to mouth plates of *Psilaster gracilis*, which, also, is not a typical *Psilaster*.

Genus DIPSACASTER Alcock.

Dipsacaster Alcock, Ann. N. H., ser. 6, vol. XI, 1893, p. 87. J. Asiat. Soc. Bengal, vol. LXII, 1893, p. 172 (no diagnosis). Type *Dipsacaster sladeni* Alcock.

Dipsacaster nesiotes new species.

Pl. IX, figs. 3, 3a; pl. X, figs. 2, 2a–b; pl. XII, figs. 1, 2.

Rays 5. R=89 mm., r=27 mm. R=3.3 r. Breadth of ray at base, between first and second superomarginals, 30 mm.; between fifth and sixth 25 mm. (See under variations.)

General form flat, depressed; rays tapering arcuately from a broad base to a bluntly pointed extremity. Disk large. Interbrachial arcs wide, well rounded, involving the first few marginal plates. Actinal area subplane. Abactinal area capable of considerable inflation, the paxillar area of rays often arched in such a way as materially to lessen the width of arm. Disk usually more or less inflated, but the integument is quite flexible, and no 2 specimens are alike in this respect. When the abactinal paxillar area is considerably inflated, the animal has a less flattened appearance and the rays appear quite narrow.

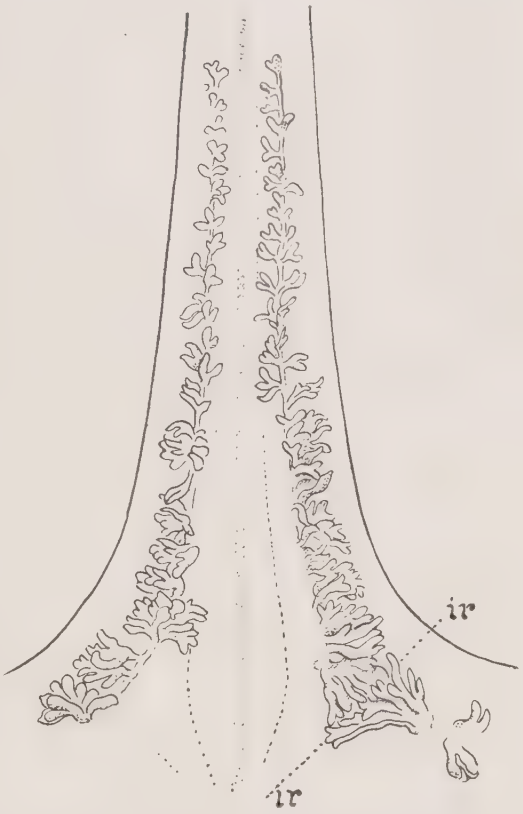
Abactinal paxillar area fairly compact, covered with paxillæ arranged on either side of the median radial line in regular obliquely transverse series. These series assume an interradial direction on the disk. On the center of disk and along median radial line no regular arrangement is apparent. Paxillæ are rather large, with a prominent pedicel which is expanded into an irregularly circular or elongated base, and a subglobose crown covered with a compact coordinated group of very many small, delicate, cylindrical, bluntly-pointed, almost capillary spinelets. An average paxilla on a ray would have 30 to 40 of these spinelets, and the larger ones on the disk from 50 to 100. One of the largest paxillæ on the madreporic body has 150. The spinelets are so compactly placed that it is almost impossible to count them accurately. Papular pores are generally distributed and are largest on the lateral portions of the abactinal area; papulæ single. Anal opening conspicuous, surrounded by a membranous periproct. It is situated about 5 mm. from the center of disk. (See p. 1028, Anatomical notes.)

The marginal plates form an angular edge to ray, the inferior series extending laterally beyond the superior and defining the margin of ray. Superomarginal plates are oblong to subquadrate, are slightly arched, and form a conspicuous border to the abactinal area, to which surface they are wholly confined on the ray. In interbrachial arc the plates are oblong, shorter than wide, and their exposed surface stands at an angle of about 45° with the horizontal. On the ray they form a low, slightly arched bevel, and at first glance appear to lie in an almost horizontal plane. Their entire width can be seen when the animal is viewed from above. Superomarginals do not exactly correspond to inferomarginals on outer half of ray, so that the suture between the 2 series follows a zigzag course. Sometimes for a short distance the inferomarginals exactly alternate with the superomarginals. But the number of plates in the 2 series is the same (in type 33). Superomarginals uniformly covered with minute pointed spinelets. In one specimen about 4 enlarged granules, with several of inter-

mediate size, stand in a group in the center of each plate (which is more arched than usual). They seem to form an incipient pedicellarian apparatus. There is a trace of them on a small specimen, but they are evidently absent from 12 others.

Inferomarginal plates encroach more upon actinal area than do the superomarginals upon the abactinal. They are wider than long, and the outer ends, which extend beyond superomarginals, form each a conspicuous boss armed with a group of short spinules. The plates are tumid along transverse axis, the summit of the elevation being along aboral margin and terminating in the outer armed end. Lateral spinules are slightly flattened, sharp, arranged in 3 close-set, irregular, oblique series on extreme margin of ray, and give a serrated appearance to the margin of arm, each tuft accentuating the tumidity of the abactinal end of its plate. They appear to be simply enlarged members of the numerous sharp squamules covering the general surface of the plate. There are deep fasciolar grooves between the plates of both series.

Adambulacral plates are longer than wide, with a convex margin to furrow, which they overhang. Armature as follows: (1) A furrow series of 7 (sometimes 8) long, stout, much flattened, subacute or blunt, knife-like spines, their bases stout and united by a short web. Their rounded edges are turned furrow-wards, and in respect to the thickness of the blade they taper slightly toward extremity. The blades are broad. Central spines slightly the longer; the outermost spine, at either end of the comb-like series, about two-thirds to three-fourths as long as the succeeding spine. (2) Following the furrow series, and placed so closely that they are pressed usually against it, is an irregular semicircular row of from 3 to 5 unequal tapering spinules, the longest never extending more than two-thirds the length of the adjacent furrow spine. The outer half of the plate bears about 12 to 18 small tapering spinelets similar to those of the actinal intermediate plates. They are arranged either in 2 or 3 irregular longitudinal rows or are scattered.



Dipsacaster nesiotes. View of cœlomic side of abactinal surface of one arm, showing arrangement of gonads, × 2; *ir*, interradial line.

Mouth plates are rather large, prominent actinally. Armature consists of 9 or 10 large, flattened, blade-like, blunt or truncate spines very much larger than the corresponding adambulacral spines. They form a graduated series, increasing in size toward the inner end of plate, where they are massive and prominent, the marginal series of 2 companion plates uniting to form, when expanded, a fan-shaped horizontal comb of about 20 teeth. Actinal surface of plate is covered with stout papilliform spinules, very similar on the outer end of plate to those of adjacent ventral intermediate plates. They increase in length toward the inner angle, where there are 2 or 3 spinules considerably larger than the rest.

Actinal interradial areas are large, paved with rather large plates which extend in regular series from inferomarginals to adambulacrals. In a specimen with 39 inferomarginals the intermediate plates extend as a single series as far as the twenty-eighth, or within 15 mm. of the tip (R = 84 mm.). A second series, smaller than that adjacent to the adambulacrals, extends to the fourteenth inferomar-

ginal, or about one-half the length of ray. A third series extends to the seventh, or one-fifth length of ray. Between first and seventh plates the longitudinal series multiply rapidly. Regarding the plates in series extending interradially, those opposite mouth plates and first 2 adambulacrals are irregular. Actinal surface of the plates convex, not raised into an abrupt and prominent keel as in some species of the genus; the convexity is most marked near the inferomarginals. Plates bear a crown of uniform, blunt, papilliform spinelets, often flower-like in appearance. On rays these spinelets tend to become slenderer. Very shallow grooves are present between the plates, roofed over by spinelets.

Madreporic body is very large (7 mm. in diameter) and is situated slightly nearer the margin than midway between it and center of disk. It is concealed by large paxillæ, there being actually on its surface about 18, one of which is much larger than the rest. Outline of madreporic body is subcircular, but the rim is irregularly scalloped.

Color in alcohol bleached brownish or yellowish. Color in life probably deep yellow, but was not recorded.

Young: The smallest specimen of this species (R = 18 mm., r = 7.5 mm.) differs somewhat from the adult, chiefly in having relatively shorter rays (superomarginals 18) and less prominent inferomarginals. These do not extend conspicuously beyond the superior series, the latter being more arched than in the adult. The inferomarginal spinules are not yet developed, the plate being crowded with rather minute, papilliform, sharp spinelets. Paxillæ have the adult character, but are much smaller. Inferomarginal spinules have appeared in one specimen with R = 34 mm.

Anatomical notes: In this species the gonads extend out into the ray, and are arranged in a longitudinal series on either side of the median radial area, depending from their respective rachides like a row of digitate glands. The largest of the genital tufts is near the interradial line, and they gradually decrease in size distad, the series ending just beyond the middle of the arm (see text figure). This arrangement of the gonads also obtains in *D. eximius Fisher*, a very distinct species from California, and although not mentioned by the describer, I believe it will also be found to hold true for *Dipsacaster sladeni* and *D. pentagonalis* Alcock. Possibly the group to which *sladeni*, the present species, and that from California belong may be subgenerically different from *pentagonalis*. Judging from the figures, the adambulacral armature of the last species is considerably different from the present species.

The anal aperture opens directly from a single sac-like intestinal cœcum, which lies in the interradius to the left of that occupied by the madreporic body. This sac, the total length of which is about two-thirds the minor radius, has a single small pocket-like branch at one side. A short intestine joins the larger sac with the dorsal stomach. The aperture of the intestine into the sac is very nearly beneath the anus, but is separated from the latter by a broad fold of the wall. Mr. Alcock, in describing *Dipsacaster sladeni* (Ann. N. H., ser. 6, vol. xi, p. 87, pl. v), states that the anal pore is not in connection with the intestine, and includes this as a character of the genus. Inasmuch as the present species is very closely related to *sladeni*, and consequently undoubtedly a *Dipsacaster*, that character can not be regarded as of generic importance.

Superambulacral plates are feebly developed, and do not extend far along the ray. They are apparently absent from the first few ambulacral plates.

Localities: Type (no. 21151, U. S. National Museum) from station 3916, south coast of Oahu Island, 299–330 fms., gray sand and mud; bottom temp., 44°. Taken also at the following stations, in all, 13 specimens:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3866	Northeast approach to Pailolo Channel, between Maui and Molokai islands.	283–284	Gray mud, fine sand.
3867	do	284–290	Fine sand, mud.
3884	do	284–290	Globigerina mud.
3908	South coast of Oahu Island	304–308	Fine white sand and mud.
3910	do		Fine gray sand and mud.

This species is most nearly related to *Dipsacaster sladeni* Alcock. It differs in the marginal plates, which do not correspond on the outer third of the ray, but alternate; in the armature of the infero-

marginals; in the arrangement of spinelets on the actinal surface of the adambulacral plates, and especially in the actinal interradial plates, which are not strongly carinated, as in *sladeni*. The dorsal stomach in *nesiotes* is connected with the intestinal cœcum by a short intestine, but is not in *sladeni*. *Dipsacaster sladeni* was dredged in the Andaman Sea, 250 fathoms.

Genus PATAGIASTER, new.

Type *Patagiaster nuttingi*, new species.

General form, character of rays, and disk as in *Dipsacaster*. Marginal plates also similar except that in the interbrachial arcs and on the basal portion of rays the inferomarginal spines form a transverse series instead of being mostly crowded at the abactinal end.

Abactinal surface very compact, the paxillæ much larger than in *Dipsacaster*, more crowded. They are flat-topped and have a central group of about 15 to 40 granules surrounded by a very numerous and regular marginal series of elongated granules, the whole resembling a composite flower. In *Dipsacaster* the paxillæ consist of many capillary spinelets in glomerular tufts on a slender pedicel, and have a quite different facies.

Papular pores absent from median radial portion of rays, and from center of disk. They do not extend beyond the madreporic body any distance toward center of disk. In *Dipsacaster* the papulæ are very numerous and generally distributed.

Actinal interradial areas large. Actinal intermediate plates, adambulacral plates, mouth plates, and their armature essentially as in *Dipsacaster*.

Superambulacral plates present, reduced to the basal half of ray. Anal opening present; connection as in *Dipsacaster nesiotes*. Gonads confined to interradial areas, not forming a longitudinal series along either side of the dorsal integument of ray.

Madreporic body large; hidden by paxillæ as in *Dipsacaster*. No pedicellariæ.

This genus is erected on the strength of the following characters: Distribution of gonads; distribution of papulæ; character of abactinal paxillæ. In these respects it differs from *Dipsacaster*. From *Plutonaster* it differs in respect to the form and armature of the marginal plates, and from *Parastropecten* in the same characters, and in possessing an anal aperture. The last character is of little importance generically. *Parastropecten* is very close to *Leptychaster*.

Patagiaster nuttingi, new species.

Pl. IX, figs. 2, 2a; pl. XII, fig. 3; pl. XVII, fig. 1.

Rays 5. R=42 mm.; r=14.5 mm. R=2.9r. Breadth of ray at base (between first and second superomarginals) 15 mm.

Disk large; rays stout, tapering from a broad base evenly to a pointed but not attenuate extremity. Interbrachial arcs wide and rounded, in some specimens with a slight tendency to become angular. General form depressed and flat, the abactinal area as a rule a trifle inflated; actinal surface plane.

Abactinal paxillar area is very compact and uniform in character, and is covered with close-set paxillæ which are largest along the margin of area and in the interradii, where they are arranged in oblique transverse rows. The median radial portion of each arm, and the center of disk, is more or less conspicuously marked off from the above areas, being covered with more crowded paxillæ scarcely more than half as large as those just described. Paxillæ of the central portion of disk are usually slightly smaller than those of the median radial area of rays. Each paxilla consists of a stout pedicel, with a slightly flaring, circular, nearly flat summit, bearing a crown of granuliform spinelets, the centrally situated ones being stouter than the peripheral. The larger paxillæ bear a central group of upwards of 30 or 35, surrounded by a peripheral series of about 25 to 30. The smaller paxillæ of the arms have about 10 granules in the central group, and 15 to 20 in the peripheral series. In specimens from other localities (e. g., station 3836) the paxillæ do not average so large, having 20 to 25 as the maximum number for the central group of spinelets. In these specimens the summit of the pedicel is slightly convex. The bases of all the pedicels are expanded into roundish, irregular, or stellate plates, the last being more prevalent in interbrachial arcs. Papular pores are confined to the area of large paxillæ, i. e., the margin of the abactinal area. They are absent from the median radial portion of rays, and from central portion of disk. Papulæ large, single.

Marginal plates are prominent, forming an angulated margin to ray. Superomarginals, 25 in number from interradial line to the extremity of ray, are confined to the abactinal surface beyond the interradial arc, the inferomarginals defining the contour of ray. They are subquadrate in the outer half of arm, but oblong in interbrachial arc, and form a low, slightly arched bevel to abactinal area. They are uniformly covered with papilliform granules which are very regular and resemble the central granules of papulæ, but are larger. Deep and narrow fasciolar grooves separate the exposed surfaces of consecutive plates, the granules covering them being slightly slenderer than the others.

Inferomarginal plates correspond with the superomarginals, and extend laterally beyond them, all this portion being the specialized ridge of the plate. The fasciolar grooves are therefore, as in *Dipsacaster*, very deep and narrow. Outer end of each plate is slightly tumid, the appearance being accentuated by the tufts of spinules. The first 4 to 6 plates bear a transverse series of 3 or 4 short, stout, tapering, flattened, sharp spinules. The other plates usually bear 2 such spinules in an oblique series on the abactinal end of the plate, but laterally. Considerable variation exists as to the number of these spinules. They are sometimes reduced in size and crowded toward the upper end of the plate (i. e., on first 4 or 6 plates) and the inner spinule is often spaced from the other 2 or 3. The general surface of the inferomarginals is covered with pointed squamiform granules which are enlarged in the neighborhood of the spinules to form a small tuft. On the abactinal surface of the plate the granules are similar to those of the superomarginals, and in the fasciolar grooves they are slender or spinuliform or capillary.

Adambulacral plates are slightly longer than wide on the rays, shortening near the mouth plates. Furrow margin convex. Armature as follows: (1) A furrow series of 7, 8, or 9 long, slender, compressed, bluntly pointed spinelets, radiating only slightly. The tips form a convex edge to the comb. The lateral spinelets are often conspicuously shorter than the others. (2) On the ray the actinal surface of each plate bears 8 or 9 shorter tapering spinelets, disposed usually in 2 semicircular rows, those of the series nearest furrow series the longer. There are besides 3 to 5 still smaller spinelets along both adoral and aboral edge of plate, extending over the grooves which separate the plates. These grooves are continuous with those passing between the actinal intermediate plates, which in turn communicate with the much deeper furrows between the exposed surfaces of marginals. The spinelets are not webbed, however. The first 3 or 4 adambulacrals possess fewer furrow spinelets (6 or 7) because the plate is shorter. The actinal spines are less crowded (15 to 23) and are arranged in a rather definite series along both adoral and aboral margins, with 2 intermediate transverse or obliquely transverse series. The first longitudinal actinal series is sometimes well defined on the plates. Many variations in arrangement occur.

Mouth plates are prominent actinally, fairly large, the exposed surface curving strongly dorsad toward the mouth. Armature consists of a furrow series of 8 tapering, long, slender spinelets, bluntly pointed and increasing in length toward the inner angle. The inner spinelets are slightly flattened and are usually turned away from the mouth, but the outer members of the series extend about halfway to the outer end of plate, to which the series is continued along the margin adjacent to first adambulacral as a row of much smaller, slenderer, spinelets (8 to 10 in number). Actinal or exposed surface bears a series of slender, tapering, bluntly pointed spinelets along margin of suture. On the mouth angle these are about as long as adjacent marginals, but rapidly decrease in length as they proceed outward, becoming short and round-tipped. On outer half of each plate an intermediate, subparallel, and similar series is present, often, however, arranged irregularly, so as to give the appearance of 2 intermediate series. Spinelets of mouth angle usually appear crowded or bunched together.

Actinal interradial areas fairly large, paved with close-set roundish plates, which extend nearly halfway to tip of ray (to ninth inferomarginal plate). These plates are arranged in series extending from inferomarginals to adambulacrals, and those plates adjacent to the latter are larger than the others. When viewed from the surface toward body cavity, the plates are seen to be imbricated, the outer end of each being slightly elongated and overlying the inner rounded end of the adjacent plate. Regarded from the actinal surface, it is the inner end which overlies the outer. On the rays this inner end is somewhat elongated, and the series adjacent to the adambulacrals slightly overlaps the outer margin of the latter. Central portion of each plate is raised into a regular paxillar tabulum with a convex summit, surmounted by a radiating central group of 6 to 10 short, rounded, subconical, pointed or blunt-tipped, granuliform spinelets, with a peripheral series of about the same number of slender, slightly longer spinelets placed at a lower level on the pedicel or tabulum. Often the central and

peripheral series are nearly alike and form a coordinate group. Fairly well defined channels run between the series of keels or pedicels, interradially from inferomarginals to adambulacrals.

Superambulacral plates are feebly developed, scarcely more than rudiments, the series extending about one-half length of ray, and absent from innermost 4 to 6 adambulacrals. They appear to be better developed in medium-sized than in fully adult specimens.

In this species the gonads are clustered on either side of the interradial line and do not extend as a longitudinal series along either side of the medio-radial line far into the ray, as in *Dipsacaster nesiotes*.

Madreporic body is fairly large, nearly hidden by paxillæ; irregular in outline; striations radiating. Situated slightly nearer to margin than midway between margin and center of disk.

Color in life: Abactinal paxillar area coral red over area occupied by small paxillæ, becoming duller or grayish coral red at the sides; actinal surface creamy white; marginal plates the same, tinged with pink. Color in alcohol, brownish yellow to ashy white.

Young: The smallest specimen taken measures R 12 mm., and r 5 mm., and in general appearance is very like the adult. The difference is a lack of enlarged spinules on inferomarginal plates. The interradial areas are already well developed, and paxillar area is compact as in adult. Another specimen of nearly the same size possesses a single enlarged spinule on the edge of the ray.

Localities: Type (no. 21152, U. S. National Museum) from station 4081, north coast of Maui, 202–220 fathoms, gray sand and foraminifera; bottom temperature, 51.7°; abundant. Taken also at the following stations, in all 414 specimens.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3836	South coast of Molokai Island	238–255	Brownish gray mud and sand.
3919	South coast of Oahu Island	257–220	Gray sand.
4044	West coast of Hawaii Island	233–198	Fine gray sand.
4082	North coast of Maui Island	220–238	Gray sand.
4083	do	238–253	Do.
4115	Northwest coast of Oahu Iaiand	195–241	Coral sand, foraminifera.
4116	do	241–282	Do.
3472	South coast of Oahu Island	295	Fine white sand.

This species is found, therefore, at a depth of about 250 fathoms and apparently does not range much over 30 fathoms either side of this average. It was taken on a special line of dredgings north of Maui which were made for the purpose of determining vertical distribution.

The chief differences between this and the foregoing species have already been pointed out. The present form is in some respects intermediate between the Astropectinidæ and Plutonasteridæ.

The species is named for Prof. Charles Cleveland Nutting.

Family LUIDIIDÆ Verrill, 1899.

Luidiidæ Verrill, revision of certain genera and species of starfishes, with description of new forms. <Trans. Conn. Acad., vol. x, 1899, p. 201. Equivalent to Luidiinæ Sladen, Challenger Asteroidea, 1889, p. 244.

Genus LUIDIA Forbes

Luidia Forbes, Mem. Wern. Soc., vol. VIII, 1839, p. 123.

Key to Hawaiian species of Luidia.

a. Rays more than 5, mottled with brown.
  b. Pedicellariæ very few; abactinal paxillæ rounded, with one or two prominent spinules; adambulacral spines 4. No inferomarginal pedicellariæ ..... *hystrix*.
  bb. Pedicellariæ numerous, conspicuous, 2 to 4 between inferomarginal and adambulacral spines; the latter 3 in number. Inferomarginal plates, with 2 to 4 pedicellariæ ..... *magnifica*.
aa. Rays constantly 5.
  b. Prominent lateral spines to ray ..... *Luidia sp.*
  bb. No prominent spines on ray ..... *brevispina*.

Luidia hystrix, new species.

Pl. XIII, figs. 1, 2; pl. XIV, figs. 1, 2; pl. XVI, figs. 2, 2a.

Rays 8. R = 195 mm. (longest ray, the shortest R being 178 mm.) r = 19 mm. R = 10.2 r. Breadth at widest part near base 20 mm.

Rays very elongate in proportion to disk, slightly swollen above base, and thence very gradually tapering up to the bluntly pointed extremity; robust, depressed, with well-rounded sides. Abactinal surface more or less flattened on disk; convex on rays, but flattened or even slightly concave along median radial line. In young specimens rays are always strongly convex above. Actinal surface rounded, the ambulacral furrow broad and tube feet very large, with conical sucking disks.

Paxillæ of abactinal area large, crowded on disk, and there without definite arrangement. They are arranged in definite, spaced, longitudinal rows along rays, except in a narrow median radial area, where they are more crowded and not so regular. On either side of this median radial area one can count 6 regular longitudinal series of paxillæ on the basal portion of ray and 5 over the remainder. Paxillæ are rotund to slightly subquadrate at the margins of area. Nearly all paxillæ of rays except the series adjacent to inferomarginal plates and those of distal portion of median radial area bear a robust, upright, tapering sharp thorn or spinule, about 2 to 2.4 mm. in length, placed in center of tabulum; those of the median radial area (proximal portion) are shorter (1.5 mm.). This spinule is surrounded by 5 to 8 or 10 robust, cylindrical or clavate, obtusely tipped, papilliform spinelets, placed also on the tabulum. External to these on the periphery of tabulum are 15 to 25 (usually about 17 or 18) slender papilliform spinelets, usually somewhat irregular in thickness. Paxillæ of the series adjacent to marginal plates are very slightly smaller than the others and lack the central spinule. Not infrequently paxillæ of the regular spinulated series also lack the spinule, but in other respects they resemble the spinopaxillæ. Occasionally paxillæ of disk bear a short conical spinelet, but most of them have instead 8 or 9 cylindrical flat-topped granuliform spinelets in the center of tabulum, surrounded by a peripheral series of 20 to 25 much slenderer ones.

Inferomarginal plates are very numerous, short, and wide, each with a special raised ridge, between which are deep fasciolar grooves. Plates bear, along the median line, a transverse series of 4 or 5 (rarely 6) long, slightly curved, very sharp, rather delicate spines. These increase in size toward outer edge of plate, the inner 2 being usually much smaller than the outer 3, the median spine of which is longest. Toward base of ray there is less difference between the inner and outer spines, although the inner 2 are always much smaller. The elevation or keel of the plate, upon which the spines are borne, is bordered by long, slender spinelets, a few standing on the exposed surface, between the spines. Sides of fasciolar grooves are covered with capillary spinelets.

Adambulacral plates are wide, but short, as seen on the actinal surface, and are united by broad bands of integument. The armature, which is borne on a sort of keel, consists of 4 spines, of which 3 form a regular transverse row, the median being longest and furrow spine shortest. The fourth spine is situated between the outer two, but adorally and out of line with the series. Near base of ray a fifth spine is added to outer end of regular series, and sometimes a smaller spinule stands in line with the odd spine, which is about the length of the furrow spine or shorter. Furrow spine is slightly curved, compressed, and saber-like. The outer spines are faintly curved at the base, are tapering, bluntly pointed, and usually directed away from the furrow. External to the outermost spine, about midway between it and the innermost inferomarginal spine, is a radiating group of 8 or 9 ciliary spinelets of different sizes. In the midst of these there is sometimes an inconspicuous 3-jawed pedicellaria, fairly wide at base, but with tapering, bluntly pointed jaws, scarcely one-third the length of adjacent adambulacral spine. These pedicellariæ, of which there is never more than one to a segment, are not numerous, being present on about half the adambulacrals of some arms and almost absent from others.

Mouth plates are long and narrow. Along the margin are about 8 long, slender, pointed spines, which increase in length toward the inner end of the plate, the innermost spine being longest, flattened, and directed toward center of actinostome. The adjacent spine is also frequently flattened. Parallel with this series, and close to it, on actinal surface, is another series of 4 similar spines. Frequently this second series is more or less irregularly grouped in with the first. True marginal spines are found on side of plate, one near base of the big inner spine, and 3 or 4 in a cluster, considerably higher up, about midway between the first and the roof of the furrow.

Actinal interradial areas small; there are apparently about 4 plates, each bearing a tuft of long slender spinelets surrounding a central spine.

Madreporic body hidden by paxillæ.

Color in life: Above, cream color, mottled with burnt sienna and chocolate; below, white. Spines white. Ambulacral feet whitish, with sucking disks of orange yellow. In young individuals the chocolate color tends to form 3 cross bands on arms, a broad one near tip, one about the middle of ray, and the third at base; the last connects with an indefinite ring of mottling about disk. Center of disk brown.

Young: In very young individuals the abactinal spinules are entirely absent, as might be expected. The smallest specimen has R=15 mm., and r=6.5 mm.; 10 rays. Another young specimen, slightly larger, has a smaller disk and 8 rays. In the young the inferomarginal and adambulacral spines are relatively smaller than in the adult, the outermost spine of the former series being the largest, the remainder quite insignificant. Pedicellariæ are entirely absent. In a specimen with R=73 mm., the abactinal spinules have appeared on all the series of paxillæ, upon which they are present in the adult; but the spinules are much smaller than in the fully adult. Judging from a slightly smaller specimen than this, the spinules appear first on the innermost regular series of paxillæ, and thence spread over the rest, never appearing on the marginal row. Most of the regular series have subquadrate paxillæ, which become more and more rounded toward median radial line. The inferomarginal spines are practically like those of the adult, the innermost 2 being a little weaker. On these intermediate specimens the adambulacral armature is as in the adult, except that pedicellariæ are very much less numerous.

Localities: Type (no. 21153, U. S. National Museum) from station 3876, Auau Channel, between Maui and Lanai islands, 28 to 43 fathoms, sand and gravel; bottom temperature, 74°. Taken also at the following stations, 11 specimens in all:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3861	Pailolo Channel	30–52	Fine sand, small pebbles, coral.
3987	Southeast of Kauai Island	55–50	Coral fragments, coarse coral sand.
4031	Penguin Bank, south of Oahu Island	27–28	Coral, fine coral sand, foraminifera.
4032	do	27–29	Do.
4034	do	28–14	Do.
4168	Vicinity of Bird Island	20–21	Coral sand, foraminifera.

This species is most nearly related to *Luidia aspera* Sladen, taken by the Challenger Expedition off Samboagan, and Tablas Island, Philippine Group, and north of Admiralty Island, the vertical range being 10 to 150 fathoms. Both species are related to *Luidia maculata* Müller and Troschel, as well as to the following species, *Luidia magnifica*. *Luidia hystrix* differs from *aspera* in the character of the adambulacral armature and abactinal paxillæ. In *aspera* only 3 inner rows of paxillæ are spiniferous. Our species has an extra spine to the adambulacral armature, and fewer pedicellariæ, there being never 2 between the inferomarginal and adambulacral spines as in *aspera*.

A young specimen was found to have engulfed a young sea-urchin and a small colony of polyzoa.

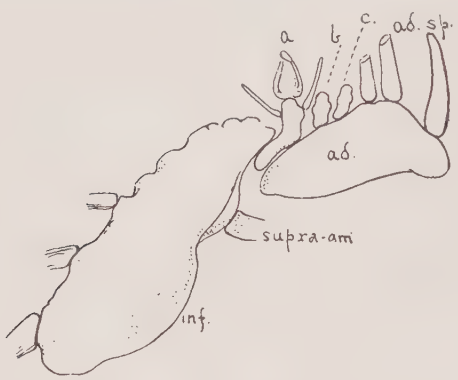
Luidia magnifica, new species.

Pl. xv, figs. 1–3; pl. xvi, figs. 1, 1a.

Rays 10. R=330 mm.; r=41 mm.; R=8r. Breadth of ray at widest part, near base, 37 mm. The outer third of the two unbroken arms has been regenerated, and although they are nearly the diameter of basal portion, they are probably considerably shorter than in life.

Rays very elongate in proportion to disk; considerably wider about 30 mm. from base than directly at junction with disk. They taper very gradually to a bluntly pointed extremity, and are robust, depressed, with well rounded sides. Abactinal surface capable of inflation, but flattened on disk; convex on rays, but flattened or even slightly concave along median radial area. Actinal surface with rounded borders. Ambulacral furrow wide, the tube feet very long, with comparatively small, ovoid sucking disks. Pedicellariæ very numerous on actinal surface.

Paxillæ of abactinal area are large, roundish on disk, and very crowded; on rays arranged in 6 regular longitudinal series at either side, becoming reduced to 5 on outer part of ray. In these regular series the paxillæ are very sharply quadrate, but over a fairly wide median radial area they are rounded in outline, considerably smaller than those of the regular series, are crowded, and have no definite arrangement. At base of ray paxillæ of all 6 longitudinal rows bear a tapering, sharp, stout, often slightly curved spinule or thornlet, those on innermost series longest (2 to 4 mm.), thence decreasing in size toward margin, being usually quite short on outer 2 rows. On outermost of marginal series (corresponding to the aborted superomarginal plates) there is now and then a central spinule as long as any of the innermost series. On outer part of ray beyond middle there are about 3 definite longitudinal rows of spinules. The spinule is borne usually near inner edge of quadrate tabulum, or near the aboral inner corner, seldom in the center. Exposed surface of tabulum is only slightly convex, and bears 20 to 25 stout, subclavate, papilliform spinelets, which become much heavier, rather flat-topped, and granuliform toward the center, where they often have the appearance of being bent the same way that the spinule is directed—namely, diagonally toward inner aboral corner of plate. Periphery of tabulum bears a series of numerous, blunt, much slenderer spinelets. Paxillæ of median radial areas and disk lack enlarged spinule, are roundish, and smaller. The central group of spinelets is also more regular, increasing in size toward the center, where they are rather flat-topped, clavate, and granuliform, resembling the large end of an apothecary's pestle in miniature.



Luidia magnifica. Inferomarginal and adambulacral plates, removed to show actinal intermediate ossicles (*a.*, *b.*, *c.*). *ad.*, Adambulacral plate; *ad. sp.*, adambulacral spines; *inf.*, inferomarginal plate; *supra-am.*, supraambulacral plate (end only), × 4.

Inferomarginal plates very numerous, short, and comparatively wide, each with a special ridge, separated from that adjacent by an unusually deep and wide fasciolar groove. Armature consists of a transverse, regular series of 5 or 6 spines, of which the outer 2 or 3 are longer than the inner. The former are long, slender, tapering, very sharp, and slightly curved. Three is the most frequent number; the longest (7 to 9 mm.) is sometimes the outer (when there are but 2 enlarged lateral spines), sometimes the median, but there is little difference in the length of the three. The inner 2 or 3 of the group of 6 are often augmented by several auxiliary spinules. This group is less regular than the outer spines, the spines being much smaller, tapering, with usually an expanded, flat, chisel-like tip. The plate is fringed by stout pointed spinelets, of considerable size, which are also scattered over surface of plate between the large spines. Here they are unequal in size, and irregular in distribution. In addition there is 1 (or rarely 2) 3-jawed pedicellaria between the large lateral spines, making 2 or 3 for each plate. These pedicellariæ, which are not to be confused with the larger ones, found in the interval between the adambulacral and innermost inferomarginal spines, are sessile, with a fairly broad base and blunt tip, being roughly conical.

Armature of adambulacral plates, which is borne on a transverse keel, consists of 3 spines, placed one behind the other, the median longest. Furrow spine flat, saber-like, and bluntly pointed. The next two are close together, and separated from furrow spine by an interval. They are long, straight, tapering, round tipped, and usually bent away from furrow. An inconspicuous, short, blunt, flat papilla is situated on adoral side of base of outermost spine. External to the latter, between it and inferomarginal spines, is a row of 3 (occasionally 4, or at end of ray 2) large 3-jawed pedicellariæ, which increase in size outward, the outermost being situated on a slightly greater prominence than the others. The innermost is situated just external to the outermost adambulacral spine, and reaches nearly halfway to top of this. Each pedicellaria is perched on the top of a discrete ossicle shaped very much like the shaft of a paxilla. The inner 2 (*b*, *c*, see fig.) rest on the surface of the adambulacral plate, but the bottom of the outermost and largest is bent, and is wedged between the adambulacral and inferomarginal, representing the usual actinal intermediate plate, evidently. These ossicles are immersed in muscle, and are not readily comprehended unless treated with hot caustic potash. They represent really 3 longitudinal series of actinal intermediate plates, something very unusual for this

genus. Each pedicellaria, perched on the knob-like tip of its ossicle, is surrounded by a circle of 5–10 papilliform spinelets of unequal lengths, the longest often reaching nearly to tip of pedicellaria. The latter has a rather broad base, with bluntly tipped jaws, which are about 1½ to 2 times as long as the extreme width of base. These jaws are often slightly twisted at tips, like the opening bud of a flower, which indeed the pedicellaria somewhat resembles, the similarity being increased by the calyx-like circlet of spinelets already mentioned. The outermost pedicellaria of this group is always largest, being usually, exclusive of its pedicel-like base, 1.5 to 2 mm. long.

Mouth plates long and narrow. The 2 inner angle spines are long, flat, round-tipped or subtruncate, much stouter than any others of the plate, and directed toward center of actinostome. The true furrow-series is continued toward the end of first ambulacral plate, in about 3 groups, each of 2 papilliform spinelets. One of these spinelets, adjacent to the tooth, is enlarged, flattened, about half as long as tooth. Extending along margin of actinal surface of plate is an irregular series of long spines, tapering and slender, and often slightly flattened at tip. They decrease in size toward outer end of plate, where there is also a marginal fringe of spinelets, extending inward along side of groove adjacent to first adambulacral. The superficial series might be regarded as 2 irregular series on the outer part of plate. Actinostome large.

Actinal interradial areas practically absent, the adambulacrals of adjacent rays with their large pedicellariæ touching each other.

Madreporic body entirely hidden by paxillæ.

Color in alcohol, yellowish brown, mottled with darker; in life probably similar to the foregoing species.

Locality: Type (no. 21154, U. S. National Museum) from station 3849, south coast of Molokai Island, 73 to 43 fathoms, coarse sand, broken shells, coral; 1 specimen.

This very distinct species is related to *Luidia maculata* and *Luidia aspera*, as well as to the foregoing species. From the last 2 it differs particularly in the character of the adambulacral armature and in the presence of 3 longitudinal series of actinal intermediate ossicles, and probably also from *maculata* in these respects. I have been obliged to rely upon the original description of *maculata* (System der Asteriden, p. 77), which is none too satisfactory, and upon the critical remarks of Perrier (Révision des Stellérides, p. 338). So far as I am aware, no one has figured *maculata*, the type of which came from Japan. Neither Müller and Troschel nor Perrier mention abactinal spines or the pedicellariæ of the inferomarginal plates, so I am forced to conclude that these are not present on *maculata*. Nor is it clear from the original description whether the large actinal pedicellariæ follow the adambulacral spines or are among them. Perrier says they follow the spines, while Müller and Troschel state that they are among or between [zwischen] them. While *magnifica* differs from *aspera* in the same respects as from *hystrix*, it may not be amiss to detail some of the differences which separate it sharply from *maculata*.

Luidia maculata.	*Luidia magnifica.*
No enlarged spinules on abactinal paxillæ.	Four to 6 lateral series of abactinal paxillæ with enlarged spinules.
Adambulacral armature consisting of one furrow and 3 or 4 actinal spines.	Adambulacral armature of 1 furrow and 2 actinal spines.
Pedicellariæ slender, 3–4 times as long as broad.	Pedicellariæ 1½ to 2 times as long as broad, 3 in number, in a definite series external to adambulacral spines.
A single series of actinal intermediate ossicles.	Two to 4 series of actinal intermediate ossicles, each ossicle bearing a pedicellaria.
Inferomarginal spines 2–3, the innermost longest.	Inferomarginal spines about 5, the outermost longest; the inner 2 with flattened chisel-shaped tips.
No pedicellariæ on inferomarginal plates.	Three or sometimes 2 or 4 pedicellariæ on inferomarginal plates between the large lateral spines.

The inferomarginal plates of this form are relatively rather small. The actinal intermediate ossicles are aberrant also. The interval between successive segments of the ray is comparatively very large, and filled with muscle. This fact, combined with the arrangement of actinal plates, gives a great degree of flexibility. Professor Verrill, to whom I sent a portion of an arm for inspection, writes that he believes this species can swim rapidly, using its large ambulacral feet as paddles, as he has seen *Luidia clathrata* do. The tube feet are very large.

This is a remarkably large species. The type, if perfect, would measure over 2 feet in diameter. It is thus nearly as large as a specimen of *L. savignyi*, with 9 arms, recorded from Mauritius, the shortest ray of which was 350 mm., the longest 370. Prof. F. J. Bell has referred to this specimen as the largest starfish on record.[a]

Luidia sp.

In the collection there is a single specimen of a young *Luidia*, which can not be positively determined on account of its small size. R=20 mm.; r=4 mm. R=5r. Rays 5, very gently tapering; abactinal area convex. Paxillæ are arranged in 4 regular rows at either side of arm. These would apparently have become subquadrate. Those of median portion of arm are round and likewise rather regularly arranged. Inferomarginal plates with a single, prominent, slender, slightly flattened spine, about as long as width of plate, forming a series along margin of ray. Actinal surface of plate with numerous slender spinelets, but none large enough to form a companion spine. Adambulacral armature consists of a long, slender, flattened, slightly curved furrow spinelet, and 2 actinal spinelets in a regular transverse series, besides 1 or 2 shorter spinelets situated adorally to the latter. Occasionally a long 2-bladed pedicellaria takes the place of one of these latter spinelets, but as yet pedicellariæ are rare. The dredge-station record is missing, but the specimen was probably taken from Penguin Bank, south of Oahu, in a depth of about 25 fathoms.

This specimen appears to belong to an undescribed species very closely allied to *Luidia forficifer* Sladen, from Torres Strait, 6 fathoms, and the Arafura Sea near entrance to Torres Strait, 28 fathoms. (Sladen, Challenger Asteroidea, p. 260.)

Luidia brevispina Lütken.

Luidia brevispina Lütken, Fortsatte kritiske og beskrivende Bidrag til Kundskab on Söstjernerne. <Videnskabelige Meddelelser, 1871, p. 288. Perrier, Révision des Stellérides, 1875, p. 337.

This species is recorded by Perrier (l. c.) from the Sandwich Islands, where 9 specimens were collected by Mr. Ballieu, and received by the Museum d'Histoire Naturelle de Paris in 1876. No examples were secured by the Albatross Expedition.

Family PSEUDARCHASTERIDÆ Fisher, 1905.

Pseudarchasterinæ Sladen, Challenger Asteroidea, 1889, p. 109; emended. Verrill, Trans. Conn. Acad., vol. x, 1899, p. 187.
Astrogoniinæ Perrier, Exped. Scientif. Travailleur et du Talisman, Echinodermes, 1894, pp. 337, 338.
Pseudarchasteridæ Fisher, Bull. Bureau of Fisheries, vol. xxiv, 1904 (1905), p. 303.

Genus PSEUDARCHASTER Sladen.

Pseudarchaster Sladen, in Narr. Challenger Exped., vol. i, 1885, p. 617.
Astrogonium[b] Perrier (non Müller and Troschel) Exped. Scientif. Travailleur et du Talisman, Echinodermes, 1894, p. 338.

Key to Hawaiian species of Pseudarchaster.

a. Rays shorter; no enlarged spinules on the actinal intermediate plates ..... *myobrachius*
aa. Rays longer; enlarged spinules on the actinal intermediate plates ..... *jordani*

[a] Bell, Ann. N. H., ser. 6, vol. iii, 1889, p. 222.

[b] The substitution of the name *Astrogonium* for *Pseudarchaster* Sladen is wholly unnecessary and unwarranted. *Astrogonium* was first proposed by Müller and Troschel (System der Asteriden, 1842, p. 52) and included 4 genera—*Hippasteria* Gray, *Goniaster* Agassiz, *Pentagonaster* Gray, and *Tosia* Gray—all of which are now recognized and in current use. The genus was thus a composite group without a definite type. In 1847 and 1866 Gray used the name in a more restricted sense, including forms now referred to *Tosia* (or to *Pentagonaster*, according to the point of view), such as *Tosia granularis* (Retzius), and to the *Odontasteridæ*, as *Acodontaster miliaris* (Gray) Verrill. If it were used at all it would be applied, with very questionable propriety, to the group containing the *Asterias granularis* of Retzius, which belongs to the previously described *Tosia*. But as *Astrogonium* was an artificial group, a synonym of, say, *Hippasteria*, or of any one of the other 3 above-mentioned genera, the name should be discarded for all time, on the ground of "once a synonym, always a synonym."

However, in 1889 Sladen incorrectly restricted *Astrogonium* to Gray's genus *Pentagonaster*.

Perrier in 1894 transferred the name to an entirely different group, one unknown to either Müller and Troschel or Gray, namely, to *Pseudarchaster+Aphroditiaster* Sladen. Both of these names are perfectly tenable, and the course of Perrier is wholly contrary to the most widely accepted laws of nomenclature. *Astrogonium* has been used by several authors since 1894 in place of *Pseudarchaster*, the correct name of the group. (See Verrill, Trans. Conn. Acad. xx, 1899, p. 149.)

Pseudarchaster myobrachius, new species.

Pl. x, figs. 6, 6a; pl. xix, 1, 1a–c.

Rays 5. R = 34 mm.; r = 13 mm. R = 2.61r. Breadth of ray at base, between second and third superomarginal, 12 mm.; halfway to tip, 7 mm.

Rays rather narrow and short, slightly tapering after the basal expansion to a pointed extremity. Interbrachial arcs wide and well rounded, so that base of rays is broad. Margin of rays evenly rounded, more beveled on disk.

Abactinal paxillar area compact and uniform; very narrow on rays, consisting of only three rows of plates on outer half, where it is less than half as wide as a superomarginal. Paxillæ roundish to subpolygonal, close-set, and not arranged with any great regularity. The pedicel is surmounted by 12 to 18 coordinated, short, truncate, 3- or 4-sided spinelets, prismatic in appearance. A few of the peripheral spinelets are usually noticeably smaller than others. Paxillæ decrease in size toward margin and on rays, where there is usually only 1 central spinelet with 7 to 9 surrounding it. A well-defined groove is present between the paxillar area and marginal plates. Papulæ absent from distal half of ray.

Superomarginal plates, 23 in number from median interradial line to extremity of ray, form a broad, conspicuous margin to abactinal area. Length in interbrachial arc less than on ray (except outer fourth). Plates are covered with a close polygonal granulation, the granules increasing in size and becoming less crowded toward outer end of plate. A marginal series of much smaller granules surrounding each plate is clearly distinguishable. Plates of outer half of arm have an oval naked spot on middle of dorsal aspect. This area begins on ninth or tenth superomarginal and is present on 9 or 10 plates. The last (distal) few plates, being very small, are completely covered with granules.

Inferomarginal plates correspond in number to superomarginals, and encroach rather more upon actinal area than do the latter upon abactinal. Plates in interbrachial arc are conspicuously shorter than those on ray. They are covered with numerous granules, which increase conspicuously in size toward outer margin of plate. Most of the granules are flat-topped, roundish, or polygonal, but many show a tendency to become squamiform. Plates of interbrachial arc bear a median transverse series of 4 flattened, tapering, sharp spinelets which have a swollen base and are closely appressed to the plate. These are reduced in number to 3 and 2 on ray, and finally to one on outer part. The series is well spaced.

Adambulacral plates have an angular furrow margin, the apex of which is nearer adoral than aboral side. The armature consists of a furrow series of 6 or 7 short, roundly truncate, flattened spinelets, 4 of which are on that side of the angular margin turned away from mouth, the longest spinelet at apex, and the other 2 on the adoral side of the margin. They thus form a palmate series and are graduated in length. Furrow series is continued along adoral margin in 2 to 5 gradually shortening spinelets, and similarly along the aboral margin in 2 or 3 spinelets. In middle of actinal surface there is an erect tapering spinule, more prominent than any others of plate, and clustered around it are numerous small, papilliform spinelets, especially toward the outer side of plate. On first few plates the prominent spinule is not present. The spinelets which are found along the adoral and aboral margins of each plate are opposed over a sort of fasciolar furrow between the plates.

Actinal intermediate plates are subquadrate or roundish, large, and do not extend beyond the third inferomarginal. They are arranged in about 3 series parallel to the adambulacrals, and increase in size toward disk. They are covered with round papilliform granules, which are truncate, well spaced, and often arranged in more or less definite rows. No fasciolar grooves are present between the plates, or if present can not be regarded as in any manner specialized.

Mouth plates are large, ovoid, and prominent actinally, with an extensive furrow margin. The armature consists of a furrow series of 7 blunt flattened spinelets, similar to but larger than the adambulacral furrow spinelets, increasing in length toward inner end of plate. These inner spinelets are slightly compressed in an interradial plane, and likewise taper a trifle. A superficial series of 10 is present along the margin of the median suture, decreasing in length toward the outer end of plate, the outermost being scarcely more than flat-topped granules. Furrow series is continued along margin adjacent to first adambulacrals in about 6 short, graduated, very flat spinelets, opposed to those of the adjacent edge of adambulacral. Between these and superficial series is a row of 3 or 4 small papilliform granules, similar to the adjacent superficial series.

Madreporic body is very small, situated halfway between center of disk and inner edge of superomarginals; entirely hidden by paxillæ.

Color in alcohol, dull brown.

Young: Two young, apparently of this species, were taken at station 4028. R=8.5 mm.; r=5 mm. (smaller specimen). They differ much from the adult in general form, having short, stout rays. Each of the broad superomarginal plates (8 in number from median interradial line) has a naked area on the abactinal surface, similar to that of the adult except that in the young these extend around the interbrachial arc. Enlarged spinules of inferomarginals are present (absent on other specimen, however), but much reduced. Actinal intermediate plates are very few, and the actinal spinule of adambulacrals is not yet larger than the others. Furrow spinelets of adambulacrals 4 to 6.

Locality: Type (no. 21158, U. S. National Museum) from station 3995, vicinity of Kauai, 427–676 fathoms, fine gray sand and rocks; bottom temperature, 40.6°. Two young specimens were taken also at 4028, southwest coast of Kauai, 444–478 fathoms, on gray sand and globigerina.

This species is distinguished by its short rays, broad marginal plates, very narrow abactinal paxillar area on rays, small actinal intermediate area, the plates of which are devoid of spines and of specialized fascioles between them, and by the enlarged spinule on the adambulacral plates. The madreporic body is entirely hidden. The species is thus very distinct from any Pacific form, and would seem to approach nearest to *Ps. tessellatus* Sladen from Cape of Good Hope, from which, however, it is readily distinguishable by the shorter rays, broader marginal plates, with naked areas on superior series, by the hidden madreporic body, and by the absence of spinules from actinal intermediate areas, where the granulation appears also much less compact.

Pseudarchaster jordani, new species.

Pl. x, figs. 7, 7a; pl. xix, figs. 2, 2a.

Rays 5. R=52 mm.; r=16.5 mm. R=3.15 r. Breadth of ray at base, between first and second superomarginals, 18 mm.

Rays moderately long, robust, tapering continuously from a fairly wide base to a pointed extremity. Interbrachial arcs not so wide as in preceding species; rounded. Abactinal surface a trifle inflated over radial areas, and slightly sunken along interradial lines.

Abactinal paxillar area is compact, not so narrow on rays as in preceding species. In the middle of R there are 5 longitudinal rows, the area here equalling in width one of the adjacent superomarginal plates. The paxillæ are relatively larger than in *Ps. myobrachius*, and are arranged with beautiful regularity in a radial and numerous parallel series, the plates decreasing in size toward margin. They are also smaller in an apical area, inside the primary radials. A radial paxilla consists of about 10 to 12 hexagonal or prismatic, granuliform spinelets placed on the convex summit of the pedicel, surrounded by a peripheral series of 15 to 18 smaller, unequal, slightly flattened ones which are considerably slenderer and do not form a regular series. The smaller paxillæ differ only in having fewer spinelets. Papulæ arranged in sixes about paxillæ, lacking from distal three-fifths of arm, as beyond eighth superomarginal.

Superomarginal plates, 30 in number from median interradial line to extremity of ray, form a slightly arched bevel to margin of ray, but do not encroach so conspicuously upon the abactinal area as in the preceding species. They are uniformly covered with polygonal, flat-topped granules which increase in size toward the lower edge of plates. The thirteenth to twenty-third plates have a rudimentary bare spot near the abactinal end, but this appears to be lacking in a second specimen.

Inferomarginals correspond plate for plate with superomarginals. On disk they encroach more upon the actinal area than do superomarginals upon abactinal. Excepting a regular peripheral series, the granulation is coarse and more irregular than that of superomarginals. The granules tend to become squamiform, and there is a very irregular transverse series of sharp, squamiform spinelets on each plate. These are more numerous in interbrachial arcs, and do not form a straight linear series.

Adambulacral plates have an angular furrow margin. Armature as follows: (1) A palmate furrow series of 7 or 8 slightly curved, stout, round-tipped, compressed spinelets. The series is continued along the aboral and adoral margins as 2 or 3 shorter, slenderer spinelets, the inner ones often standing on furrow margin in such a way as to form a portion of the palmate series. (2) On the general surface of plate, 2 (rarely 3, often only 1) lanceolate, slightly flattened sharp spinules similar to those of the actinal intermediate plates. Surrounding these are 6 or 7 blunt, papilliform spinelets,

those on the outer edge of the plate being much slenderer and smaller than those adjacent to the furrow series. The former sometimes form an irregular longitudinal series. The enlarged spinules usually stand in an obliquely longitudinal or even transverse series.

Actinal intermediate plates extend as far as fifth inferomarginal. The series adjacent to adambulacrals is much the largest. Each plate bears near the center 1 (occasionally 2) lanceolate, sharp, flattened, appressed spinule surrounded by well spaced, small spinelets which increase in size from the edge toward center of each plate. The peripheral series is slender, but the more centrally situated spinelets are clavate with flattened, subsquamiform tips. There appear to be rudimentary fascioles between the plates, especially those adjacent to adambulacral series. The granules become more flat-topped and subsquamiform near the inferomarginals.

The armature of the mouth plates is robust, consisting of a furrow series of stout, curved, round-tipped spinelets, slightly compressed, which are subequal in size, or a trifle smaller at the inner third of the series, and a trifle larger than the corresponding spinelets of the first adambulacral plate. There is an odd spine at the inner end of the combined pair, in addition to the regular marginals. There is a regular series of about 9 along the margin of the median suture, the inner 2 or 3 spinelets round-tipped and of about the same size as the adjacent furrow spinelets, the outer graduated and bluntly pointed, clavate or papilliform. The furrow series is continued along the margin adjacent to the first adambulacral, in 5 or 6 smaller spinelets, which increase in thickness toward the outer end of the plate.

Superambulacral plates present, feebly developed; lacking beyond eighth inferomarginal.

Madreporic body small, nearly hidden by paxillæ, situated very nearly midway between center of disk and inner edge of superomarginal plates.

Color in alcohol, bleached yellowish.

Locality: Type (no. 21159, U. S. National Museum) from station 3474, south coast of Oahu Island, cruise of 1891, 375 fathoms, fine white sand, 2 specimens.

This species differs from the foregoing in having larger rays, more prominent paxillæ, which are very regularly arranged, one or two enlarged spinules on each actinal intermediate plate, and either one or two enlarged spinules on all the adambulacral plates. It bears closest resemblance to *Pseudarchaster tessellatus* Sladen, from Simons Bay, Cape of Good Hope. From this species it differs in having shorter and wider mouth plates, which appear, in addition, to be relatively smaller. The 2 lineal series of spinelets are not subparallel, but outline a triangle, the base of which is the superficial series adjacent to the median suture. The marginal plates encroach more upon the dorsal and ventral areas, especially in the case of the inferomarginals. The granulation of the latter is coarser than that of superomarginals, instead of being of uniform size, as in *tessellatus*. The furrow series of spinelets is coarser, and there are usually 2 actinal spinules, instead of 1 on each adambulacral plate. The abactinal paxillæ contain more spinelets, and appear to be slightly larger, and the madreporic body is much smaller or at least less exposed. This form is also related to *Ps. mozaicus* Alcock from the Indian Ocean, but differs in having shorter rays, which are broader at the base, less numerous marginal plates, and actinal interradial plates which extend to the fifth, instead of tenth, inferomarginal. Minor differences are apparent in the armature of the mouth and adambulacral plates.

A second specimen has the following measurements: R=59 mm.; r=15 mm. R=3.9 r. Thus the rays are a trifle longer than those of *tessellatus*, and judging from the figure in the Challenger report (Asteroidea, pl. XVII, figs. 3 and 4) are also more robust and more gradually and evenly tapered from the interbrachial arc.[a]

Family BENTHOPECTINIDÆ Verrill, 1899.

Benthopectinidæ Verrill, Revision of certain genera and species of starfishes with descriptions of new forms. <Trans. Conn. Acad. Sci., vol. x, 1899, p. 217. = Pararchasterinæ Sladen.

Subfamily PONTASTERINÆ[b] Verrill, 1894.

Pontasterinæ Verrill, Descriptions of new species of starfishes and ophiurans, etc., <Proc. U. S. Nat. Mus., XVII, 1894, p. 246.

[a] After this report was completed and had left my hands three species, *Ps. pectinifer*, *Ps. pulcher*, and *Ps. verrilli*, were described by Ludwig (Mem. Mus. Comp. Zool., Vol. XXXII, July 17, 1905, p. 106–120). *Ps. jordani* resembles the first two forms, but lacks any structures that might be considered pedicellariæ. From *pulcher*, *jordani* differs, also, in having actual intermediate spines, and a much more extended papular area, reaching to supermarginal plates and interradial line. *Ps. pectinifer* is from Gulf of Panama, and *pulcher* from southwest of Acapulco, and vicinity of Galapagos Islands.

[b] Classified by Verrill under his Plutonasteridæ. The present classification is that advocated by Sladen in "Challenger Asteroidea."

Genus CHEIRASTER[a] Studer.

Cheiraster Studer, Sitzungsber. naturforsch. Freunde Berlin, 16 Oct., 1883, p. 130; Anhangz. d. Abhandl. d. k. preuss. Akad. d. Wiss. Berlin, vom Jahre 1884, p. 49, Taf. IV, figs. 8, a, b, c; Taf. V, figs. 9, a b, c, d, e. Type, *Cheiraster gazellæ* or possibly *pedicellaris* Studer.

Pontaster (partim) Sladen, Narr. Chall. Exp., I, 1885, p. 610.

Key to Hawaiian species of Cheiraster.

a. Pectinate pedicellariæ on actinal surface ..... *snyder*

aa. No pectinate pedicellariæ.

b. Abactinal paxillar area bristling with erect spinules. Rays rather short ..... *horridus*

bb. No erect, abactinal spinules. Rays long and slender ..... *inops*

Cheiraster snyderi, new species.

Pl. x, fig. 3; pl. xviii, figs. 1 and 3.

Rays 5. R = 51 mm.; r = 9 mm. R = 5.6r.[b] Breadth of ray at base (between first and second superomarginals) 8.5 mm.

Rays long and slender, tapering gradually to an elongate pointed extremity. Disk rather small. Interbrachial arcs wide and rounded. Lateral wall vertical. The marginal plates form a narrow, slightly raised border to abactinal paxillar area, which is subplane. Pectinate pedicellariæ on actinal surface.

Abactinal paxillar area is not uniform, the paxillæ being of various sizes, spaced, and rather small, decreasing in size toward tip of rays. Larger paxillæ of disk bear 6 to 9 short, papilliform spinelets surrounding a central group of 2 or 3, or sometimes only 1. Scattered among these are smaller paxillæ of all sizes, some with only a single little spinelet, others with 3, 4, 5, or 6, and so on up to the largest. Paxillæ on rays bear 4 to 6 spinelets, usually widely radiating, and on outer half of arm a few along median radial area may have a single, central, delicate, conspicuous spinule standing erect. Those paxillæ on papularium are different from the others, being more ornate, with longer spinelets, which radiate to form rosettes. Midway between center of disk and margin, on each interradial line, is a single enlarged paxilla with 20 to 25 spinelets. One of these is situated adcentrally to the madreporic body. Papulæ are large and confined to an oval area at base of rays (papularium), there being about 25 to 30 of them, distributed in 4 irregular longitudinal rows, the 2 medium series longest.

Marginal plates form a slightly raised border to disk and rays, which have vertical sides. Plates of lower series alternate with those of upper, except on outer third of ray, where they very nearly correspond. Superomarginal plates, 33 in number (in cotype) from median interradial line to extremity of ray, are about as high as broad, except in interbrachial arc, where the height is much the greater. They are slightly tumid, form a rounded margin, and the prominent transverse sutures follow an oblique course, trending from within outward and orad. First superomarginal smaller than succeeding ones. Each superomarginal bears 1 short, sharp, cylindrical, tapering spine, at about the center of plate. These diminish in length as they proceed outward and are usually absent from the first superomarginal and reduced in size on second. General surface of plates is covered with small, rather widely spaced papilliform spinelets. There is a small abnormal, odd interradial superomarginal in one interradius.

Inferomarginals form a rounded and conspicuous border to the actinal area, on which their breadth exceeds their length, on inner half of ray, while the reverse is true for outer half. Each plate bears a lateral, cylindrical, tapering, sharp spine, 3.75 mm. long, situated near outer or upper margin and pointing horizontally out from ray. These spines diminish in length as they proceed outward, and are reduced to about half usual size on first 2 inferomarginals. Below each spine, in a rude semicircle, is a group of 3 or 4 spinules similar to but smaller than the lateral spine. One of these is larger

[a] Ludwig (Mem. Mus. Comp. Zool., vol. xxxii, 1905, p. 1) has united *Cheiraster* Studer and *Pontaster* Sladen (as restricted by Perrier). Pectinate pedicellariæ can not be used as a generic character, for they may be lacking in species normally having them. I have followed Ludwig. *Cheiraster horridus* and *Cheiraster inops* would belong to the restricted genus *Pontaster*, according to those authors who prefer to recognize *Pontaster* as distinct.

[b] In the description the proportions have been taken from the cotype, since tip has been broken from all the arms of the type, which is a considerably larger specimen, r = 11.25 mm.

than the others, and forms a companion spine on all but first 4 or 5 plates. Sometimes a second spinule nearly equals it. General surface of plates is covered with spaced, sharp spinelets or thornlets, which are longest and stoutest along median transverse line, especially in vicinity of spines and spinules. A narrow area at inner end of plates, adjacent to adambulacrals, is usually free from spines, except on about 5 plates beyond the second to fourth. These have 3 or 4 sharp, short spinelets set close together in a comb, and pointed over the suture between inferomarginals and adambulacral plates, sometimes meeting 1 or 2 smaller spinelets on the latter, or arranged in a semicircle without opposing spinelets. These are rudiments of the peculiar pectinate pedicellariæ characteristic of the genus, and which in this species are better developed on the actinal intermediate plates.

Adambulacral plates have an acute angular projection into furrow, the spiniferous rim appearing semicircular. Greatest breadth is greater than length; successive plates rather widely separated. Armature as follows: (1) A furrow series of 8 (occasionally 6 or 7) slightly flattened, blunt spinelets. The 4 or 5 median spinelets form a nearly straight series, are untapered and round-tipped. One or 2 spinelets at either end of series are shorter than the central group of 4, and the lateralmost are shortest. (2) On actinal surface a tapering, stout, erect, pointed spine, a third longer than those of furrow series, stands in the middle of plate, and on an oblique line toward outer adoral corner is a companion spinule, much shorter and slenderer. A second slightly shorter spinule, near the aboral margin of plate, is in a longitudinal series with the last, while a similar third spinelet is sometimes found just aborally from the prominent spine. These 3 spinules are usually all present (but not always) and near base of ray either the first or second may be considerably enlarged. A row of 2 or 3 short, slender spinelets continues the furrow series along adoral margin of plate.

Mouth plates prominent, broad, and the united pair strongly convex, with a wide free margin. Width of united pair exceeds interradial dimension. Each plate bears a marginal series of 7 flattened, tapering, blunt spines and spinules, disposed in a radiating horizontal series. The innermost spine is longest, the second slightly shorter, and the combined 4 stand out horizontally over peristome forming "teeth." The remaining 5 spinelets are either graduated in length, or form an independent fan-shaped series at sides of the margin. On actinal surface a row of 5 or 6 prominent pointed spinules extends along margin of interradial suture, decreasing in length as they proceed outward. About 3 widely spaced spinules are scattered between the above series and the marginals, often forming an intermediate series.

Actinal intermediate plates are few and do not extend beyond fourth adambulacral. There are 8 or 9 pectinate pedicellariæ to each of the 5 interradial areas. These pedicellariæ are situated over a suture between 2 plates, the 4 or 5 spinelets (making up comb) of one plate opposing an equal number of the adjacent plate, the suture running between them. The largest pedicellaria is that on interradial line. The others are smaller. There is considerable variation in the number of these pedicellariæ, the smaller specimen possessing but 2 to 4 to each interradial area, and lacking entirely the largest. Numerous delicate thornlets are scattered over intermediate plates.

Anal aperture subcentral, small, but easily seen.

Madreporic body of medium size, broadly elliptical, situated midway between center of disk and margin. Striations coarse, very irregular.

Color in life unknown; in alcohol ashy white.

Young: The smallest specimen (station 4007) has R=11 mm., and r=3 mm., and a considerably different facies from the adult. The marginal plates are very broad and massive, and encroach upon the abactinal paxillar area. Paxillæ relatively large, especially on disk. Adjacent to the margin in each interradius is a large, round paxilla, evidently the same as that which in the adult is situated about midway between margin and center of disk (basal plate of apical series). There is another smaller plate situated at the base of the ray, in the median line, which probably represents the radial plate. There is only 1 papular pore to each ray, just distad from the radial plate. Madreporic body minute. Spines of marginal plates small. No actinal interradial plates; no pedicellariæ. Adambulacral plates widely separated. Furrow series of spinelets only 3 or 4; actinal adambulacral spinelet 1, with an aborally situated companion. Mouth plates like adult, characteristic. A larger specimen with R=28 mm. has 4 or 5 actinal intermediate plates and a couple of pedicellariæ to each area. There are scattered spinules on abactinal surface of disk, as well as on rays.

Localities: Type (no. 21155, U. S. National Museum) from station 3997, southwest of Kauai Island, 418–429 fathoms, fine gray sand and brown mud; bottom temperature 41°. Seven specimens

taken also at the following stations: 3981, southeast of Kauai, 636–414 fathoms, globigerina ooze; 3995, north of Kauai, 427–676 fathoms, fine gray sand and rocks; 3998 southwest of Kanai, 235–228 fathoms, coarse brown coral sand, shells, rocks (very young, probably this species); 4007, vicinity of Kauai, 508–557 fathoms, gray sand, foraminifera (very young). All but types are immature specimens.

Cheiraster horridus, new species.

Pl. x, fig. 5, 5a; pl. xvii, fig. 3; pl. xviii, fig. 2.

Rays 5. R=35 mm.; r=7 mm. R=5r. Breadth of ray at base (between first and second superomarginals) 7 mm.

Rays rather short for genus, tapering very gradually from a narrow base to pointed extremity, which is reflexed. The ray tapers more perceptibly in outer than inner half, giving a stout appearance. Disk small. Interbrachial arcs regular but well rounded. Lateral walls vertical. Marginal plates form a broad, but not raised, border to abactinal area. Abactinal surface of disk and rays subplane; actinal areas subplane; margins of rays well rounded. No pedicellariæ whatsoever.

Abactinal paxillæ are fairly large and distinctly spaced, the plates varying in size and having no definite order. They are irregularly hexagonal, or polygonal, and the convex, spine-bearing surface is only slightly raised above level of sutures. Larger paxillæ of disk bear 15 to 20 small cylindrical spinelets, surrounding in 1 or 2 irregular series a long, slender cylindrical spine (3 to 4 mm.) which stands erect. These spines are numerous on disk, and about 10 scattered, very large paxillæ bear from 2 to 4 accessory spinules about half as long as the spine. On a few of the paxillæ a rosette of enlarged spinelets surrounds base of spine. On rays the spines are numerous, but reduced to one-third or one-fourth the size of those on disk; deciduous and usually not more than 1 to a paxilla. Scattered among the larger paxillæ of disk are numerous small ones, consisting of a central spinelet and 4 to 9 in a rosette surrounding it. Very small paxillæ bear a group of 3 or 4 spinelets. Papulæ are few, very inconspicuous, and are confined to the basal portion of each ray. No specialized papularium is evident.

Marginal plates form a conspicuous border to disk and rays. Plates of the two series are not exactly opposite (except the first pair), but alternate, so that the sutural line between the 2 series is regularly zigzag. Superomarginal plates, about 20 in number from median interradial line to extremity of ray, are about as wide as high, except in interbrachial arc, where height is greatest. They form a conspicuous margin to paxillar area, which on arms is equal to twice the width of 1 series of plates. First plate much smaller than succeeding. Each superomarginal on outer or marginal angle bears a conspicuous slender, tapering, sharp spine, 2 to 3 mm. in length, which stands out at right angles to side of ray. They decrease in size toward tip of ray, and are surrounded each by 2 to 6 smaller spinules of different lengths, the longest being about one-half length of spine. Rest of plate is covered with tiny, spaced spinelets. There are prominent but shallow furrows between the plates.

Inferomarginals are distinctly tumid, and form a rounded and elevated border to the actinal surface. Each plate bears from 5 to 8 slender, tapering, bristling spines and spinules, either disposed in an oblique transverse group, or (on outer half of ray) forming a more compact group on lateral surface of plate. The spines are of different lengths, the longest being equal to superomarginal spine. There are usually 3 nearly as long, while the remainder vary from one-third to one-half the length of longest. Scarcely 2 plates have the armature arranged exactly alike. General surface of plates is covered with small, slender, sharp spinelets, rather widely spaced. A number in the vicinity of spines are enlarged.

Adambulacral plates have a prominent angular projection toward furrow, the furrow margin being rounded or semicircular in outline. Armature as follows: (1) A palmate furrow series of 5 or 6 slender, untapered (or but very slightly tapering), flattened, round-tipped spinelets, the median longest and all slightly radiating. Along adoral margin of plate there are 2 to 4 tiny, slender spinelets, simulating a continuation of the furrow series. (2) On actinal surface of plate are 2 robust, tapering, acute spinules forming an oblique series, the axis of which would extend diagonally across the plate from outer adoral to inner aboral corner. The outer spine is longest (2 mm. on inner half of ray), the inner about equaling longest of furrow spinelets. One or 2 of the delicate adoral thornlets are sometimes found in close proximity to the larger spine.

Mouth plates are broad and convex, the combined width of 2 plates equaling the interradial dimension. Marginal spinelets 7, increasing in length toward inner angle, the innermost being long, tapering, and blunt, the next not quite so long. The 4 spines of companion plates form prominent teeth. The most aborally situated spinelet of furrow series (i. e., the seventh) is about one-third the length of the third spinelet from inner angle, the third spinelet two-thirds length of median teeth. Actinal surface bears 10 or 11 small, scattered spinelets, of which about 3 on each plate are enlarged into spinules.

Actinal interradial areas are very small, with 6 plates, the 2 innermost (opposite mouth plates) much the largest, tumid, and surmounted by 1 or 2 central spinules and 6 or 8 tiny thornlets, like those of inferomarginals. The other plates bear a few thornlets.

Anal aperture nearly central, very small.

Madreporic body small, circular, with coarse striations; situated about its own diameter distant from marginal plates.

Color in life: Abactinal surface vermilion, the tip of arm, and a broad V-shaped transverse band about midway along ray whitish. Actinal surface white. Color in alcohol, ashy white.

Locality: Type (no. 21156, U. S. National Museum) from station 4079, north coast of Maui Island, 143–178 fathoms, gray sand and foraminifera; bottom temperature 60.8°.

This species shows no signs of pectinate pedicellariæ. It is quite different from any described species; the numerous spines on the abactinal surface and bristling armature of both series of marginal plates at once distinguish it. *Pontaster hispidus* Wood-Mason and Alcock, and *Pontaster pilosus* Alcock from the Indian Ocean evidently have pectinate pedicellariæ. The only Pacific forms of "*Pontaster*" (s. s.) are *subtuberculatus* from east of Australia and *planeta* from west of South America, near Straits of Magellan. Both of these forms are widely different from *horridus*. On account of its bristling armature and the absence of a specialized papularium, *horridus* resembles the young of *Acantharchaster* Verrill, which lack pectinate pedicellariæ. In the present form, however, the papulæ seem to be lacking from disk except adjacent to base of rays.

Cheiraster inops, new species.

Pl. x, fig. 4; pl. xvii, fig. 2.

Rays 5. R=50 mm.; r=7.25 mm. R=6.9r. Breadth of ray at base (between first and second superomarginal plates) 8.5 mm.

Rays long, slender, tapering gradually from a narrow base to an elongated pointed extremity. Disk small. Interbrachial arcs angular, but rounded. Lateral walls vertical. Marginal plates form a rather narrow, slightly raised border to abactinal area, which is subplane. No pedicellariæ.

Abactinal paxillæ smaller than in preceding species; well spaced; abactinal integument rather flexible. The paxillæ, which conspicuously decrease in size toward tip of ray, consist on disk of 9 or 10 very short papilliform spinelets, in a circle, surrounding a central group of from 1 to 4 spinelets. Along median radial area of arm and center of disk numerous scattered paxillæ bear a single, central, short, sharp, tapering spinule. On rays there are usually 5 or 6 very short spinelets surrounding a single central one to each plate. In each interbrachial arc, about midway between center of disk and margin, is 1 paxilla much larger than any other, bearing a coordinated group of about 25 spinelets. Scattered among the larger paxillæ of disk are numerous very small ones. Papulæ are large, confined to an elliptical area at base of rays (papularium), there being 4 longitudinal rows, the 2 median nearly twice as long as the lateral, and their papulæ also larger. Papularium is more prominent in a mutilated specimen than in type, there being 5 to 8 papulæ in the lateral series and 8 or 9 more widely spaced in the median.

Marginal plates of lower series alternate with those of upper, as in foregoing species, the first inferomarginal being opposite first and second superomarginals, the sutural line between the 2 series following a regular angular zigzag course throughout ray. Superomarginal plates, 30 in number from median interradial line to extremity of ray, are higher than broad, except on outer half of ray, where the 2 dimensions are about equal. The plates are tumid and form a rounded, slightly elevated border to paxillar area, the sutures between the plates being set obliquely, as is usually the case in this genus. First superomarginal is conspicuously smaller than the succeeding. Each plate bears a short (1.75 to 2 mm.), tapering, pointed spinule, rather nearer the outer than inner margin of plate. These spinules are borne on the angle where lateral and dorsal superficies meet, and are usually bent upward.

On outer attenuate part of ray they become much reduced in size. First superomarginal either lacks the spinule or bears a very small one. General surface of plates is covered with scattered, small, papilliform spinelets.

Inferomarginals form a rounded and conspicuous border to actinal area, on which their length is greater than their breadth. They are slightly higher than the superior series. Each plate, on lateral face and near upper angle, bears a prominent, cylindrical, tapering, sharp spine, which stands out horizontally from ray. These spines are about 3 mm. long, and decrease in length at tip of ray. Below this are grouped 3 to 5 shorter and more delicate spinules, often in a rude semicircle, the longest being one-half to two-thirds the length of spine. On the inner plates of ray these accessory spinules are usually placed in an irregular transverse series, accompanied by numerous enlarged spinelets. Surface of plates is covered with spaced, usually sharp, papilliform spinelets.

Adambulacral plates have an angular projection into furrow, the spiniferous rim being rounded to subangular. Greatest breadth is greater than length. Armature as follows: (1) A palmate furrow series of 7 slender, tapering, blunt spinelets, the 3 or 4 median subequal, or the median slightly the longest. (2) On actinal surface 1 conical, erect, pointed spine stands in center of plate. On outer part of ray a second smaller spinule is present in an oblique line toward inner aboral corner of plate. This spinule seems to be represented throughout rest of ray by a slender spinelet on the aboral border of plate. First 2 adambulacrals have a second smaller spine toward the furrow angle, but this does not appear to hold for all the rays of the type specimen. Three or 4 small spinelets stand in a row along adoral margin of plate, forming a continuation of furrow series. One or 2 similar spinelets are also occasionally found on outer end of plate near inferomarginals.

Mouth plates prominent, broad, and the united pair strongly convex, with a wide semicircular free margin. Their interradial length about equals width of united pair. Each plate bears a marginal series of 8 spinelets, the 2 innermost enlarged into flattened, slender, slightly tapering spines, which project horizontally over the mouth and with those of the companion plate form 4 "teeth," the 2 median of which are a trifle the longest. The other marginal spines are about half the length of teeth, and diminish in size as they recede from them. On actinal surface of each plate is a linear series of numerous spinelets, running parallel to median suture, which decrease in size as they proceed outward. Between this series and lateral margin, and much nearer inner than outer end of plate, stands a single prominent spine similar to that which is found on the actinal surface of each adambulacral. Numerous small miliary spinelets are found on outer half of each plate.

Actinal interradial areas small. Intermediate plates 10 to 12, convex, armed with small, widely spaced, spinelets. Intermediate plates extend only as far as the fourth adambulacral, and usually not beyond third.

Anal aperture nearly central, easily detected.

Madreporic body small, subcircular, situated about midway between center of disk and margin, marked with coarse radiating striations. There is a large paxilla on its adcentral side.

Color in life unknown; in alcohol ashy white, yellowish on arms.

Variations: In a large mutilated specimen which appears to belong to this species the disk is relatively slightly larger, and interbrachial arcs more rounded. The papularium is more prominent also. Each adambulacral plate bears a second smaller spinule in an oblique line toward the outer adoral corner of plate. The inferomarginal plates are slightly broader on actinal surface than in type. It is barely possible this may represent another closely related species, but with the material at hand it is impossible to determine this. The species of *Cheiraster* are as a rule very variable.

Localities: Type (no. 21157, U. S. National Museum) from station 3865, Pailolo Channel, between Molokai and Mauai, 256–283 fathoms, fine volcanic sand and rocks; bottom temperature 44.8°. Station 3868, same locality, 294–684 fathoms, fine gray sand and rocks. Cruise of 1891, 3474, south coast of Oahu, 375 fathoms, fine white sand; 8 specimens.

This species can readily be distinguished from the preceding by the longer, slenderer rays, very much less spiny dorsal integument (the spinules being inconspicuous), and less spiny marginal plates. It is apparently more nearly related to *Ch. planeta*, taken by the Challenger Expedition in 245 fathoms off the western coast of South America (near the entrance to the Straits of Magellan, opposite Port Churruca) than to any other known form. From *planeta*, *inops* would be readily distinguished by its relatively smaller disk, more attenuate, longer rays, more numerous papulæ in the papularium, and by the considerably larger abactinal paxillæ. The armature of the inferomarginal and adambulacra; plates also presents points of difference.

Family ARCHASTERIDÆ Viguier, 1878 (emend).

Archasteridæ Viguier, Anatomie Comparée du Squellette des Stellérides.<Arch. Zool. Expér. et Génér., t. VII, 1878, p. 235 (separate). Verrill, Trans. Conn. Acad., vol. X, 1899, p. 201; restricted to genus *Archaster*.

Genus ARCHASTER Müller & Troschel.

Archaster Müller and Troschel, Monatsber. d. k. Akad. d. Wiss., Berlin, 1840, p. 104; System der Asteriden, 1842, p. 65. Emended by Sladen, Challenger Asteroidea, 1889, p. 120. Type *Archaster typicus* Müller and Troschel.

Archaster typicus Müller & Troschel.

Archaster typicus Müller and Troschel, Monatsber. d. k. Akad. d. Wiss. Berlin, April, 1840, p. 104. J. E. Ives, Proc. Philad. Acad. Sci. 1889, p. 175.

This well known and widely distributed species was not taken by the naturalists of the *Albatross*, although considerable work was done on reefs and dredging was carried on in shallow water. A specimen collected by W. H. Pease is recorded by J. E. Ives (op. cit., p. 175) from the "Sandwich Islands". He says: "The specimen from the Sandwich Islands differs from the others by its narrower arms and greater number of arm plates, having about 40 to each side of an arm, whereas others have only about 35. It differs also in color, being of a very light cream color instead of light or dark umber. This however may be due to fading of the original tint".[a]

An examination of several Samoan specimens reveals the fact that there is some variation in the length and breadth of the rays, while the number of superomarginal plates may be as great as 52.

This species has a certain resemblance to some forms of *Astropecten*, but may be readily distinguished from any member of that group by the absence of superambulacral plates, and by the presence of a very well defined median radial series of paxillæ.

Family GONIASTERIDÆ Forbes, 1840 (pars).

Goniasteridæ (pars) Forbes, A History of British Starfishes, etc., 1841. Verrill, Trans. Conn. Acad., vol. I, 1867, p. 343. Perrier, Révision des Stellérides, 1875, p. 185.
Pentagonasteridæ Perrier, Mém. sur les Étoiles de Mer, etc., 1884, p. 231. Sladen, Challenger Asteroidea, 1889, p. 260.

Key to Hawaiian genera of Goniasteridæ.

a. Whole test not overlaid with a fairly thick skin or membrane, obscuring the plates.
  b. Abactinal area with tabulate paxilliform plates, either rounded or stellate on the papular area.
    c. Abactinal plates round, on the radial papular areas connected by internal, slender, very regular, radiating ossicles which are independent of the plates.....MEDIASTER
    cc. Abactinal plates strongly stellate, 4 to 5 lobed, imbricating by the tips of the processes, which are stout.....NEREIDASTER
  bb. Abactinal area paved with rounded or polygonal plates which may be smooth and bordered by a single series of granules, or their surface may be covered with granules. They may bear isolated spines and short tubercles, or may be covered with short spines and granules invested in pulpy sheaths. Plates not tabulate nor papilliform.
    c. Form pentagonal to stellate. Superomarginal plates separated on ray by at least one series of abactinal plates; or occasionally 1 or 2 distal superomarginals are in contact medially.
      d. No prominent spines or tubercles on any of the plates. No enlarged actinal adambulacral spines. Abactinal plates smooth or granuliferous.
        e. Granules more or less bead-like. No large bivalved pedicellariæ.
          f. Marginal plates very large and few, the second superomarginal conspicuously larger than either the first or third. Abactinal area granulose.....PENTAGONASTER
          ff. Marginal plates few to many, evenly graduated in size, neither the second nor any subterminal superomarginal conspicuously larger than the preceding plates.....TOSIA

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[a] After this paper was ready for the press I received from Dr. H. A. Pilsbry, of the Philadelphia Academy of Sciences, the above specimen. I have nothing to add to Mr. Ives's observations, except that very few of the superomarginals bear a small upright tubercular spinelet. In one of the Samoan specimens these are conspicuous. The number of superomarginals is not great for the size (R=60 mm., r=10.5 mm.), since a specimen from Samoa, with R=65 mm., has 48 superomarginals. The armature of the adambulacral plates is the same in Hawaiian and Samoan examples.

ee. Abactinal plates covered with flat granules of considerable size, and irregular, often grotesque shapes. Numerous large bivalved pedicellariæ on both surfaces, but not on marginal plates. Marginal and actinal plates covered with polygonal or irregular granules ..... GILBERTASTER

dd. Marginal plates with rigid tubercular spines, or tubercles.

e. Distalmost 2 or 3 superomarginal plates in contact medially. Abactinal plates smooth, having a central tubercle on the radial series ..... CALLIASTER

ee. Marginal plates separated throughout the ray. Abactinal, marginal, and actinal plates bearing conical spines surrounded by granules sheathed in a thick, pulpy, investment. EVOPLOSOMA

cc. Form stellate; many of the distal superomarginal plates in contact medially. Rays slender, at least in outer part; disk well developed.

d. Abactinal plates smooth, bordered by small, oblong, roundish, or quadrate granules. Actinal plates bearing a few central, tubercular granules, and bordered by bead-like granules. Inferomarginal plates without spines ..... ASTROCERAMUS

dd. Abactinal plates granuliferous, bearing erect sharp spines on radial areas. Inferomarginal and actinal intermediate plates bear prominent, mobile, sharp, appressed spines ..... CALLIDERMA

aa. The whole test covered by a membrane or skin obscuring the outlines and surface of the plates.

b. Papulæ single, medium-sized, not in areas. Abactinal membrane smooth. All granules of test are beneath the membrane. Plates polygonal or roundish, close-fitting. Pedicellariæ elevated, spatulate, pincer-shaped ..... ANTHENIASTER

bb. Papulæ very small; in areas. Integument or skin closely beset with small superficial granules. Plates strongly stellate. Pedicellariæ small, low, slit-like, as in *Pentaceros* ... GONIODISCIDES

Subfamily MEDIASTERINÆ Verrill, 1899.

Mediasterinæ Verrill, Revision of Certain Genera and Species of Starfishes, with Description of New Forms. <Trans. Conn. Acad., vol. x, Aug. 1899, p. 177.

Genus MEDIASTER Stimpson.

Mediaster Stimpson, Journ. Bost. Soc. Nat. Hist., vol. vi, 1857, p. 490, pl. 23, figs. 7-11. Type *Mediaster æqualis* Stimpson.
Isaster Verrill, Proc. U. S. Nat. Museum, vol. xvii, 1894, p. 257. Type *Archaster bairdii* Verrill.

The following species of *Mediaster* differs from *M. æqualis*, the type of the genus, in several important respects. The internal connecting ossicles [a] of the abactinal plates are absent from a very definite triangular interradial area, the roundish or somewhat irregular plates being there in close contact, and the papulæ consequently absent. In *Mediaster æqualis*, however, both the papular pores and the radiating connecting ossicles are present right up to the interradial septum, there being only a narrow area, where the septum attaches to the abactinal integument, free from papulæ and ossicles. The appearance, when prepared specimens of the two forms are viewed from the internal side, is quite different. In *Mediaster ornatus* the pedicellariæ are more pincer-like, especially on the actinal surface, instead of being low as is the case with *æqualis*. In the Hawaiian species the granules of the abactinal paxillæ are more delicate, ornate, and are not so closely crowded on top of the tabulum as in *æqualis*. In *ornatus* the furrow spines are 6 or 7 in number, delicate and compressed, and disposed in very regular combs. In *æqualis* they are 3 to 5, stout, unequal, subprismatic, not different in thickness from the 2 actinal series.

Mediaster ornatus, new species.

Pl. xvi, figs. 3, 3a–b; pl. xx, figs. 1, 2.

Rays 5. R=52 mm.; r=21.5 mm.; R=2.42 r. Breadth of rays at base, 21 mm.

Regularly stellate, with a broad disk, usually inflated over radial areas, and with symmetrical, regularly tapering rays, which have a broad base. Rays bluntly pointed. Interbrachial arcs wide and rounded. Sides of body well rounded, actinal surface plane.

Abactinal paxillar area covered with medium-sized, ornate, tabulate paxillæ, arranged in regular series parallel with the median radial. Paxillæ of radial regions and center of disk are more widely

[a] Ludwig (Mem. Mus. Comp. Zool., vol. xxxii, 1905, p. 126) has described *Mediaster elegans* (west of Cocos Island), in which there are no internal connecting ossicles.

spaced and are larger than those of the triangular interradial areas. Paxillæ of median radial series largest, thence decreasing in size toward tip of ray and sides of body. In the radial areas where paxillæ are spaced, the papulæ (1 to a pore) occur in sixes about each plate, emerging between the internal connecting ossicles. Over a triangular interradial area, however, the papulæ are wanting and the paxillæ are closely crowded. Similarly on outer third of arm the plates lose their special tabulate character, the papulæ disappear, and the plates become subhexagonal, closely united, and covered with a coordinate granulation identical with that of adjacent marginal plates. Median radial series extends to terminal plates. As already pointed out, the plates of radial papular area are well spaced, are round, and connected by very regular slender radiating ossicles, there being 6 ossicles radiating from each plate, and each ossicle common to 2 plates. The ossicles terminate abruptly at border of the triangular interradial area, being coextensive with the paxillæ. The tabulum of each plate is roundish, or in the median radial series elongated transversely. It is crowned by a central group of 4 to 6 small, thimble-shaped granules (in radial series) surrounded by about 15 to 17 longer pinched granules on the periphery. Paxillæ at sides of radial areas have only about 3 granules in the central group, and 12 to 15 in the peripheral series; while on the interradial areas they are still smaller. There is considerable variation in the number of granules, there being in some specimens a greater number than above indicated. A few small 2-jawed upright pedicellariæ, each jaw about the size of a granule, are scattered over the paxillæ of disk. They may occur either in the center of tabulum or on the edge. These pedicellariæ are very simple in construction, being but slightly modified granules. Each jaw curves toward its companion, the opposing faces being flat. Anal opening distinct, surrounded by about a dozen granules.

Superomarginal plates, 23 in number from median interradial line to extremity of ray, are broader than high in the interbrachial arc, and about as broad as high on the rays, forming a well-rounded margin to the abactinal area. They are not massive or tumid, nor do they encroach conspicuously upon the paxillar area. On ray they are nearly quadrate, but shorten considerably in the interbrachial arc, and are covered with small, uniform, roundish granules, low thimble-shaped in general form, a peripheral series of slightly longer ones being in evidence. In the center of a few plates of the interbrachial arc is a small pedicellaria, similar to those of the abactinal paxillæ.

Inferomarginal plates correspond in number with superomarginals, but are not opposite to them, being nearly alternate on the rays. Like the superomarginals they form a rounded margin, and are covered with a similar granulation. As a rule there are no pedicellariæ on the inferomarginals.

Adambulacral plates are subquadrate with a nearly straight margin to furrow. Armature as follows: (1) A furrow series of 7 untapered, truncate, subequal spines, strongly compressed and rather delicate, which form a regular comb, their tips conforming to a slightly curved line, and their bases united by a delicate web. (2) On the actinal surface, well spaced from the furrow series, a longitudinal, regular, slightly curved series of 5 to 6 stout, subprismatic (3-or 4-sided) bluntly pointed spinelets about two-thirds the length of those of furrow series and rather more robust, but like them decreasing in length toward tip of ray. Well spaced from the first actinal series, near outer margin of plate, is a longitudinal row of 5 or 6 long, flat-topped or pointed quadrate granules, larger than those of adjacent actinal intermediate plates, between which and the adambulacral granules a bare furrow is present. Near the adoral edge of plate, between the first and second actinal series, a subprismatic spinule or granule may be present which is a constituent of the second series out of line. A tapering spinelet is sometimes similarly present between the furrow and first actinal series.

Mouth plates have a long furrow margin, the companion plates forming a regular angle overhanging mouth and nearly closing the actinostome. Armature as follows: (1) A furrow series of 11 flattened spines, similar to those of the adambulacral plates, which increase in size toward inner angle, the inner 3 being conspicuously larger and broader than the others, and round-tipped, or subtruncate. (2) On the actinal surface a superficial row of spinelets extending along the median suture margin, decreasing in length to mere granules on outer end of plate. The inner members of this series are chisel-shaped. A series of 3 or 4 spinelets runs parallel with the furrow series, and, turning abruptly, is continued along margin adjacent to the first adambulacral in about 4 graduated, prismatic granules. Space between superficial (suture) series of companion plates is conspicuous, elliptical.

Actinal intermediate areas are large, paved with irregularly quadrate or roundish plates which bear subacute or round-tipped prismatic or thimble-shaped granules in a central group and a regular peripheral series, the former being a trifle smaller than the latter. These granules have a pinched

appearance, as if distinctly spaced, and are not so crowded as are those of *Mediaster æqualis*. The plates extend along ray to fifteenth inferomarginal, the outer plates being very small and isolated one from another. A few plates bear a low, upright, 2-or-3-jawed pedicellaria, similar to those of the abactinal surface. In some specimens the pedicellariæ consist of little more than 2 or 3 but slightly differentiated granules in a group. On plates adjacent to adambulacrals the pedicellariæ are usually higher, more differentiated, and have rather narrow subspatulate jaws. In one specimen most of the actinal pedicellariæ have 3 jaws, and one has as many as 5. These are higher than the abactinal pedicellariæ, the latter having jaws no larger than the granules.

Madreporic body situated one-third the distance from center; rather small. Striations coarse and characteristic of genus—namely, irregularly radiating but with the furrows interrupted at the central end. Adcentrally to madreporic body is a large paxilla.

Color in alcohol, bleached yellowish or pinkish.

Variations: After the foregoing description was written, and the figures made, 26 additional specimens, most of them adult, were received from the U. S. National Museum. These were taken by the *Albatross* in 1891 off the south coast of Oahu Island. In these specimens the abactinal paxillæ are relatively larger than in the type and fit closer together over the radial papular areas. The abactinal pedicellariæ are larger than those of type, and much more numerous. They are more like the pedicelliariæ of *æqualis*. They appear almost identical with pedicellariæ of *Mediaster bairdii*, possibly a trifle higher. In some specimens they are very thickly scattered over both radial and interradial areas, there being often 2 pedicellariæ on the radial paxillæ. The actinal granules are strongly prismatic.

Considering the specimens collectively, both those from Kauai and Oahu, the chief variations appear to be, in addition to the pedicellariæ, in the number and character of the granules on paxillæ. In some specimens these are more thimble-shaped or roundish, while in others they are distinctly prismatic.

Localities: Type (no. 21160, U. S. National Museum) from station 4022, east coast of Kauai Island, 399–374 fathoms, coral sand, foraminifera, rocks; bottom temperature 41°. Taken also at the following stations, in all 35 specimens.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3997	Southwest of Kauai Island	418–429	Fine gray sand, brown mud.
4019	East of Kauai Island	550–409	Gray sand, foraminifera.
4021	do	286–399	Coral sand, foraminifera.
4028	Southwest of Kauai Island	444–478	Gray sand, globigerina.
4123	Southwest coast of Oahu Island	352–357	Fine gray sand and mud.
4141	East of Kauai	437–632	Volcanic sand, foraminifera.

Cruise of 1901:

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3474	South coast of Oahu Island	375	Fine white sand.
3475	do	351	Do.
3476	do	298	Do.

This species appears to be most nearly related, so far as appearance is concerned, to "*Nymphaster*" *florifer* Alcock, from the Andaman Sea, 130–250 fathoms, which is probably not a *Nymphaster*, but a *Mediaster*.

Genus NEREIDASTER Verrill.

Nereidaster Verrill, Trans. Conn. Acad., vol. x, 1899, p. 186. Type *Nymphaster symbolicus* Sladen.

The genus *Nereidaster* was erected for the reception of *Nymphaster symbolicus* Sladen, and *Nymphaster bipunctus* Sladen. "In this group the pedicellariæ are high and spatulate, as in *Goniaster* [*Plutonaster* Perrier] and the adambulacral spines are in very regular parallel rows." (Verrill, l. c.) There is also a single median row of abactinal plates between the superomarginals, which may or

may not attain the tip of the ray. In *bipunctus* most of the superomarginals of the ray are in contact, but in *symbolicus* the abactinal plates extend to the tip of the arm.

I have entertained some doubts as to the propriety of ranking the following species under this genus, but it appears to be closer to *Nereidaster* than to any other known genus. The stellate character of the abactinal plates is not mentioned by Sladen in the descriptions of *symbolicus* and *bipunctus*, as dissection is necessary to determine this point, but the abactinal paxillæ and adambulacral armature, as well as the nature of the pedicellariæ, are essentially the same in the three forms. The condition of the rays, whether long or short, and the degree to which the distal superomarginals are in contact in the median line is apparently not a matter of generic importance.

Nereidaster bowersi, new species.

Pl. XVI, figs. 4, 4a; pl. XVII, fig. 4; pl. XXI, fig. 1.

Rays 5. R=68 mm.; r=32 mm. R=2.15 r. Breadth of ray near base (between fifth and sixth inferomarginals) 23 mm.

Disk very broad, somewhat inflated; rays rather short, stout, tapering to a bluntly pointed extremity. Sides of body rounded, the marginal plates well developed but not massive. Interbrachial arcs very wide and well rounded.

Abactinal paxillar area paved with large, low, tabulate paxillæ, arranged in longitudinal series parallel with the median radial. Paxillæ of latter series are largest, and all decrease in size toward extremity of ray and laterally toward the edge of disk. Paxillæ of the central portion of disk are slightly smaller than at about the middle of each radius. Those of radial areas are hexagonal as to the tabulum, and are considerably elongated transversely in the radial and each adradial series. They become more roundish toward the sides of rays. The triangular interradial area is set off more or less sharply from the radial (the paxillæ being smaller, quadrate or subrhomboid, close-set) and is devoid of papulæ. The papulæ are absent likewise from the outer third of the arm, where paxillæ become suddenly close-set, lose their tabulate character, and are reduced to simple hexagonal plates. Between the distal 8 or 9 superomarginal plates these are reduced to a simple series (the plates often quadrate), which dies out near the tip of ray, the last 2 or 3 superomarginals being medially in contact. In the cotype none of the superomarginals are in contact. Each paxilla springs from a very strongly stellate base, each plate having ordinarily 5 lobes except in the interradial series, where the plates are likely to be rather irregular and with only 3 or 4 lobes. The plates imbricate by the tips of these lobes, between which, in the radial areas, issue the papulæ. The latter are small and single. The tabulum of each paxilla is very low and is surmounted by numerous granules, the number of which varies through wide limits, according to the size of the plate. Over the papular area the granules of peripheral series are slightly pinched, low, square-tipped, more delicate, and often longer than the central granules, which are cylindrical, thimble-shaped, often flat-topped, and on the broader paxillæ of radial area are arranged in 2 or 3 more or less regular transverse series. A large radial paxilla has about 30 to 35 marginal granules and 25 central; while the smaller interradial have 14 or 15 peripheral and 5 or 6 central. In the latter the difference between the central and peripheral granules is hardly noticeable. In the type most of the paxillæ or proximal portion of radial areas and central portion of disk bear in the center a small pedicellaria with 2 (occasionally 3) slender jaws, which are chisel-shaped or spatulate and only slightly longer than the granules.

Superomarginal plates, 25 in number from median interradial line to extremity of ray, are confined almost entirely to side wall in interbrachial arc, but on outer part of ray encroach upon paxillar area, there forming a rounded margin. In interbrachial arc they may be described as forming a very steep bevel. On rays they are much larger, but are not so broad. General surface is covered with numerous low, flat-topped, thimble-shaped granules, there being a very regular peripheral series slightly larger and a trifle more widely spaced. A few pedicellariæ similar to those of the abactinal plates occur at the base of the ray. Distal 2 or 3 plates are in contact medially in type.

Inferomarginals correspond in number with superomarginals, but are not always exactly opposite to them at base of ray. They are much wider than high in interbrachial arc, there conspicuously encroaching upon the actinal interradial area. Outer edges of plates in the middle of interbrachial arc are shorter than the inner ends, like the stones of an arch. Throughout most of the ray the plates are quadrate, but in the interradial arc, and toward tip of ray, they become more and more oblong. Covering of plates is similar to that of the superomarginals. Pedicellariæ rarely present.

Adambulacral plates are subquadrate with a slightly convex margin to furrow. Armature as follows: (1) A furrow series of 7 or 8 slender, parallel, round-tipped or truncate spines, strongly flattened in a plane crosswise to furrow. The central spine is longest, the series being graduated toward either end and forming an elegant and regular comb with a strongly convex edge. The lateral spines are somewhat tapered, and all are united for a short distance above the base by a thin web. (2) On the actinal surface, well spaced from furrow series, a longitudinal row of robust, 4-sided, round-tipped, or truncate spines, either tapered or not. They are stouter, but scarcely so long as the longest furrow spine. Proximal plates have 5 spines, the laterals being very short, scarcely more than granules. Throughout the greater part of the disk there are 3 subequal spines, with a granule at the adoral end of the series and sometimes a smaller spine to the aboral. These become reduced to 2 more tapering and roundish spines on the outer part of the ray. Along the outer margin of plate is a regular series of 4 to 6 irregularly prismatic granules, with 1 or 2 continued along the transverse margins for a short distance. An odd spinelet is sometimes present on proximal plates of the series, on the adoral margin, between the furrow and first actinal series.

Mouth plates of fair size but not prominent, with a truncate outer end, and a long narrow margin. Actinal surface is slightly convex, rising toward the medium suture. Armature: (1) A furrow series of 13 (to 15) round-tipped, strongly compressed spines, which increase in size toward the inner end of plate. The series is not evenly graduated, the inner 3 or 4 spines becoming suddenly longer than the others, which are subequal in length with the furrow spines of the first adambulacral. (2) Parallel with the furrow series is a row of 6 to 8 spines similar to the actinal spines of adambulacrals, and forming a linear series with them. The outer portion of the plate is covered with flat-topped, polygonal granules, a superficial series along the margin of the median suture being usually evident.

Actinal interradial areas are large and paved with irregularly polygonal, quadrate, or roundish plates which decrease in size toward the margin and extend along the ray to sixteenth inferomarginal, or to within 15 mm. of the tip. Beyond the eighth inferomarginal there is but a single series. The plates are covered with numerous low, spaced, thimble-shaped granules, some of which, on the periphery, tend to become quadrate. The granules do not quite attain the edge of the plate, so that a conspicuous shallow furrow surrounds each group of them. On many of the plates of the series adjacent to adambulacrals is a small, 2-jawed pedicellaria similar to but larger than those of the abactinal surface. They have narrow spatulate blades. A few are scattered over the remainder of actinal intermediate area.

Madreporic body of medium size, larger than the surrounding paxillæ, situated nearer center than midway between it and margin of disk. Striations irregular.

Color in alcohol, pinkish gray to pinkish brown.

Variations: The cotype differs from type principally in having the superomarginals separated throughout the ray, the distal 5 to 7 by only a single series of abactinal plates. The paxillæ crowns are slightly more convex, and fewer of them bear entrenched pedicellariæ.

Localities: Type (no. 21161, U. S. National Museum) from station 4134, west coast of Kauai Island, 324–225 fathoms, fine coral and volcanic sand; bottom temperature 43.3°. Taken also at 4132, same locality, 257–312 fathoms, fine gray sand and mud.

Judging solely by external appearances, the *Pentagonaster arcuatus* of Sladen (Challenger Asteroidea, p. 277, pl. LII, figs. 1 and 2, pl. XVIII, figs. 5 and 6) appears to be related to the present form, although the former may be a *Mediaster*. It is not possible to tell exactly until the structure of the abactinal plates is known. *Arcuatus* is not a *Pentagonaster* in the restricted sense.

Named for Hon. George M. Bowers.

Subfamily GONIASTERINÆ Verrill, 1899.

Goniasterinæ Verrill, Revision of Certain Genera and Species of Starfishes, with Description of New Forms. <Trans. Conn. Acad., x, 1899, p. 200.

Genus PENTAGONASTER Gray.

Pentagonaster Gray, Ann. N. H., vol. VI, 1840, p. 280. Type, *P. pulchellus* Gray.
Astrogonium (pars) Müller and Troschel, System der Asteriden, 1842, p. 55.
Stephanaster Ayres, Proc. Boston Soc. Nat. Hist., vol. IV, 1851, p. 118. Type, *S. elegans* Ayres = *P. pulchellus* Gray.
Pentagonaster (Sect. A, a, pars), Perrier, Révision des Stellérides, 1875, p. 12.
Astrogonium, Sladen, Challenger Asteroidea, 1889, pp. 263, 285.
Stephanaster, Perrier, Exp. Trav. and Talisman, 1894, p. 402. (This is antedated 11 years by *Pentagonaster*.)
Pentagonaster, Verrill, Trans. Conn. Acad., vol. x, 1899, pp. 147, 157.

Pentagonaster as here used includes the old species, *P. pulchellus* Gray, *P. abnormale* Gray, *P bourgeti* (Perrier), *P. gunni* Perrier, and *P. dubeni* Gray. It is thus employed exactly as emended by Verrill (1899, p. 157). The following species is nearer to the genus *Tosia*, apparently, than are any of the above-mentioned forms.

Pentagonaster ammophilus, new species.

Pl. XVI, figs. 5, 5a; pl. XXII, figs. 1, 2.

Pentagonal, flat, with nearly straight sides, or in some specimens faintly incurved; not produced into rays. R=24 mm.; r=20 mm. R=1.2 r.

Marginal plates are large, subquadrate, but wider than long, slightly convex, the upper and lower series corresponding except at corners of disk, where there are 2 inferomarginals to 1 superomarginal. There are in the type 6 upper and 8 lower plates on each side of the pentagon. The superomarginal plates form a broad, slightly raised bevel to margin of body, the edge of the pentagon being abruptly rounded. Four plates take up the greater part of each side, the plate nearest the ocular being small. Of these 4 plates the 2 median are smaller than either penultimate plate. The 2 distal plates at each angle are in contact medially. The distalmost plate varies much in size, sometimes being very small, and usually is of widely different size from the opposite companion. Terminal plate is small. General surface of superomarginals is beset with widely scattered, round, inconspicuous granules set in shallow pits, except in the outer (lateral) edge, which is covered with similar, larger, crowded granules. The line of demarcation between the 2 zones is abrupt but irregular, the crowded granules being confined to the vertical side of the disk. On inner margin there are usually 2 or 3 irregular longitudinal series of granules. Surrounding each plate there is, besides all of the above, a very distinct and regular series of bead-like granules.

Inferomarginals are similar to superomarginals in shape, but form a slightly raised border without a bevel. They are similarly beset with granules, there being rather more along the inner and along the transverse margins.

Abactinal surface is plane or very slightly convex. Plates are flat, closely set, regularly hexagonal, in 5 longitudinal rows along the radii, the median radial row easily distinguished and most regular. They are irregularly 5- or 6-sided, on interradii and center of disk, and much larger in latter area, the (apparent) basal and radial plates of the apical system being easily distinguishable. All abactinal plates are covered with close-set, bead-like granules, microscopically pitted or roughened. A peripheral series, more regular and often slightly elongated, especially on plates of radial areas, incloses a central group, which are either coordinated or else arranged in concentric rows. A typical plate from interradial area has 40 granules in the peripheral series, and 75 to 80 in the central group. The larger plates nearly double this number. On 3 or 4 of the regular plates in each radius, and usually on 1 or 2 in an interradius, set in a little pit, is a small 2-jawed, slender, subspatulate pedicellaria. These jaws are ordinarily widely gaping, and rest in special depressions. Base of each jaw is much wider than the distal end.

Adambulacral plates are about twice as wide as long, conspicuously smaller than actinal intermediate plates, and form a very regular series on either side of the narrow furrow. Armature as follows: (1) A furrow series of 4 short, untapered spinelets, strongly compressed, edgewise to furrow. They have round tips and interlock with those of the opposite side of furrow. Either lateral spinelet is somewhat weaker than the 2 central members of the series. (2) On actinal surface 3 (sometimes 4) longitudinal series, each with 2 short, blunt, slightly flattened spinelets, which decrease in size as they recede from furrow. They are not very regularly arranged, and sometimes a fourth row of 2 or 3 spinelets is added, especially along outer half of furrow. There are thus from 6 to 11 spinelets on the actinal surface of each plate—usually about 8.

Actinal intermediate plates are large, mostly rhombic, arranged in fairly definite rows parallel to the furrow, the plates decreasing in size as they recede from furrow. They are covered with coarse, cylindrical, round-tipped granules, larger, longer, and less crowded than those of abactinal surface. The special pits of these pedicellariæ are usually surrounded by 4 or 5 more pointed granules, a cleared space being present immediately around the group.

Mouth plates are not raised above the general actinal surface. Companion plates are closely united, their combined width equalling interradial dimension. Free margin of each plate straight, the combined plates forming a rather sharp angle. Furrow series of spinelets is 10, similar to but

slightly shorter than those of adambulacrals, though larger at the inner angle, and tending to become prismatic. The actinal surface is beset with 10 or 11 spinelets, 6 of which are a continuation of the inner, actinal series of adambulacrals and resemble them. A series of 4 or 5 smaller spinelets runs along the suture margin from outer corner of plate, and meets the first series about halfway to the inner end. In the angle thus formed 1 or 2 spinelets may be present in large specimens.

Madreporic body is very small, with a few irregular coarse striations. It is situated at one-fourth the distance from center to margin of disk.

Color in life: Abactinal surface, coral red; actinal surface, whitish. In alcohol, bleached yellowish, both sides.

Variations: The chief variation in this species is probably due to age. At any rate the smaller specimens have more acute angles to the pentagon, the sides of which show a tendency to become incurved very slightly. The number of marginal plates is fairly constantly $\frac{6}{8}$. Occasionally 1 or 2 of the marginals is abnormally divided obliquely or longitudinally. Young specimens show more irregularity in the number of marginal plates, since the small distal plate may be absent. One specimen (R=18 mm.) has the following formulas for the 5 sides: $\frac{5}{7}$, $\frac{7}{6}$, $\frac{6}{6}$, $\frac{7}{7}$, $\frac{6}{6}$; another (R=11 mm.): $\frac{5}{8}$, $\frac{5}{8}$, $\frac{6}{8}$, $\frac{6}{8}$, $\frac{6}{8}$.

Localities: Type (no. 21162, U. S. National Museum) from station 3919, south coast of Oahu Island, 257–220 fathoms, gray sand; bottom temperature, 45.6°. Taken also at following stations: 4081, north coast of Maui, 202–220 fathoms; 4082, same locality, 220–238 fathoms; 4083, same locality, 238–253 fathoms; all on gray sand.

This species may be readily distinguished by its strictly pentagonal form, by the very massive marginal plates, which are few in number (only 3 to a "ray" in the upper series) and especially by the fact that the distalmost but one of the superomarginals is conspicuously larger than the rest. Also the actinal and abactinal plates are granular and bear pedicellariæ. *Pentagonaster ammophilus* is very distinct from any other species of the genus, none of which are so regularly pentagonal. In the relative sizes of its marginal plates it resembles most nearly *P. bourgeti* Perrier, although the latter has 4 superomarginals to a ray instead of 3, and 2 small plates between the terminal and enlarged superomarginal instead of 1, as in *ammophilus*.

Genus TOSIA Gray.

Tosia Gray, Ann. N. H., vol. VI, 1840, p. 281. Type *T. australis* Gray.
Astrogonium (pars) Müller and Troschel, System der Asteriden, 1842, p. 55.
Tosia, Gray, Synopsis, 1866, p. 11, pls. III and XVI.
Pentagonaster (Sec. A, b, pars) Perrier, Révision des Stellérides, 1875, pp. 200, 204.
Pentagonaster (pars), Sladen, Challenger Asteroidea, 1889, p. 264. Perrier, Exped. Trav. and Talisman, 1894, pp. 389, 390.
Tosia, Verrill, Trans. Conn. Acad., vol. X, 1899, pp. 148, 158.

Key to Hawaiian species of Tosia.

a. Abactinal plates naked, bordered by a series of small spaced granules. Pedicellariæ conspicuous. *ceramoidea*

aa. Substellate; abactinal plates small and numerous, covered with granules ..... *micropeltata*

Subgenus PLINTHASTER Verrill.

Section B. *Plinthaster*, Verrill, Trans. Conn. Acad., vol. X, 1899, p. 161.

Tosia (Plinthaster) ceramoidea, new species.

Pl. XVI, figs. 6, 6a; pl. XXII, figs. 3, 4.

Form pentagonal, flat, slightly prolonged at the angles, where 2 of the marginal plates are in contact medially. Sides are fairly straight in fully grown specimen, but in young are decidedly incurved. R=36 mm.; r=25 mm. R=1.44 r.

Marginal plates are large, but relatively much smaller than in *P. ammophilus*, and do not encroach so conspicuously upon dorsal and ventral areas. Sides of body perpendicular or superomarginal plates slightly overhanging inferomarginals. The dorsal and ventral series of marginal plates correspond in position—i. e., do not tend to alternate, the suture between the 2 series being nearly straight. There are, in type specimen, 14 superomarginals and 16 inferomarginals. Superomarginal plates are slightly tumid, about as broad as high, forming a rounded, slightly overhanging edge to the disk. The cord

of the height of each plate exceeds the length. Two distal superomarginals are in contact medially at each disk angle. The general surface is smooth, though microscopically roughened with regular pits and bosses, but on it are about 30 scattered, low, round granules set in shallow depressions. These are usually absent from a narrow zone around the margin. A regular series of flat, roundish, bead-like granules surrounds each plate, and on the dorsal surface there are 1 or 2 small, 2-valved spatulate pedicellariæ on a few of the plates nearest interradial line. Terminal plate is small, armed with a short, blunt spinelet.

Inferomarginal plates encroach upon actinal area more than superomarginals upon abactinal; slightly tumid; twice as broad as high, forming a slightly raised, rounded border to the actinal surface. Width slightly exceeds the length. The surface is beset with scattered granules, similar to those of superomarginals but more numerous, and each plate is surrounded by a regular series of bead-like granules. A narrow zone along upper or lateral face of plate is usually free from scattered granules, and 1 or 2 spatulate pedicellariæ usually take their place. Distal inferomarginal is diminutive.

Abactinal surface is very slightly convex to plane, often depressed in interradial areas. On radial areas plates are regularly circular, or faintly hexagonal, fairly large, close-set, the spaces between them being occupied by papulæ. The latter are absent from interradial areas, where the plates are less regular, usually hexagonal, sometimes quadrate or pentagonal in outline, and of less uniform size. All plates decrease in size toward the margin, and toward center of disk. The general surface of a plate is nearly flat, destitute of deciduous granules, but roughened by numerous minute bosses or low protuberances. Surrounding each plate, and occupying space between adjacent plates, is a peripheral series of flattened bead-like granules, with rounded or flattened tips. Numerous pedicellariæ, similar to those of marginal plates, are present on abactinal surface.

Adambulacral plates are about as wide as long, with straight furrow margin, but often with an angular outer margin. They are conspicuously smaller than the adjacent series of actinal intermediate plates. Armature as follows: (1) A furrow series of 7 (sometimes 6 in smaller specimens) stout, blunt spinelets, compressed, placed edgewise to furrow. They stand subparallel, and usually perpendicularly to actinal surface. (2) Following these, on the actinal surface, a longitudinal series of 3 short, blunt spinelets about two-thirds the length of furrow spinelets. Then comes another longitudinal irregular row of 3 or 4 blunt, conical granules, and on outer edge of the plate a series of slightly smaller granules 4 to 7 in number. The ambulacral furrow is very narrow, the furrow spines of the 2 sides interlocking.

Actinal interradial areas paved with rather large plates, mostly irregularly 4-, 5-, and 6-sided. They are arranged in fairly definite series parallel to adambulacrals, and the plates diminish in size toward the margin, the largest plate being in the angle adjacent to mouth plates. All are covered with numerous, coarse, but not crowded, rounded or subconical granules, and a more or less definite peripheral series is distinguishable on each plate. A few plates toward the mouth angle bear 1 or 2 two-jawed spatulate pedicellariæ, similar to those on the marginal and abactinal plates.

Mouth plates are plane, each with a straight free margin. Marginal spinelets, 7 or 8, are blunt, stout, and about as long as furrow spinelets of adambulacrals, of which series they are a simple, straight continuation. Most of the spinelets are 3- or 4-sided, and increase slightly in size as they approach the inner angle. On the actinal surface there is a row of 3 to 5 smaller, irregular, often pointed, thick spinelets parallel to furrow series, and a row of several low, rounded, or subconical granules along margin of medium suture and 3 or 4 along that edge of plate adjacent to first adambulacral plate. The outer end of the united pair of mouth plates is broadly truncate. Granules are conspicuously larger than those of the actinal intermediate plates.

Madreporic body relatively larger than that of *P. ammophilus*, about the size of surrounding plates; subcircular; striations of medium coarseness, irregularly radiating. The body is surrounded by small flat granules, like rest of abactinal plates.

Color in life, buff pink; in alcohol bleached yellowish to whitish.

Variations: A small specimen (R=21 mm.; r=12 mm.) has the sides of the disk decidedly arcuate, the relation of the major to minor radius being as 1.75 to 1, instead of 1.44 to 1, as in the type. Superomarginals of young specimen encroach more upon abactinal area than do those of the adult.

Localities: Type (no. 21163, U. S. National Museum) from station 3883, Pailolo Channel, between Maui and Molokai Islands, 277–284 fathoms, globigerina ooze; bottom temperature 45.2°. Taken also at the following stations: 3865, same locality, 256–283 fathoms, fine volcanic sand, rocks; 4082, north

of Maui, 220–238 fathoms, gray sand; 4096, northeast approach to Pailolo Channel, 272–286 fathoms, fine gray sand.

This *Tosia* appears to belong to Verrill's "Section B. *Plinthaster*" (op. cit., p. 161), which probably deserves recognition as a subgenus. The subgenus is thus characterized: "Pedicellariæ with narrow blades are present, of small size, about equal to the granules or but little larger. Adambulacral plates are wider, about as large as the actinal plates, and bear many crowded spinules; usually 4 to 6 in the furrow series. Marginal and abactinal plates usually naked in the middle and often areolated. Three to five of the dorsal marginal plates are usually in contact medially" (op. cit., p. 161). The only modifications to this diagnosis which our species would necessitate is that the pedicellariæ are decidedly larger than the granules, and adambulacral plates are smaller than adjacent intermediate plates. The present species would line up with *T. compta* Verrill and *T. nitida* Verrill from the West Indies, in which pedicellariæ occur in both series of the marginal, and on the abactinal plates, and are set in special bilobed pits. Upper marginal and abactinal plates are granulated around the edges. In our species there are scattered granules on the upper marginal series of plates in addition to those around the edges, while there are also pedicellariæ on actinal intermediate plates. The special bilobed pits are shallow.

This species is the first of the subgenus to be recognized from the Pacific, the others being Atlantic.

A fair figure of the general form and appearance of *Tosia* (*Plinthaster*) *perrieri* (Sladen) is to be found in Perrier, Expeditions Scientifiques du Travailleur et du Talisman, pt. 1, Echinodermes (pl. 25, figs. 1a, 1b). Probably Professor Verrill considers this the type of the subgenus.

Subgenus CERAMASTER Verrill.

Section C. *Ceramaster* Verrill, Trans. Conn. Acad., vol. x, 1899, p. 161. Type *Tosia granularis* (Retzius), i. e., *Asterias granularis* Retz.

Tosia micropelta, new species.

Pl. xxi, fig. 2; pl. xxvi, figs. 4, 4a.

Stellate; rays 5. R=56 mm.; r=29 mm.; R=1.93r. Breadth of ray between first and second superomarginals, 28 mm.

General form flat, with a large disk, produced into 5 short rays, which taper evenly from a broad base to a bluntly-pointed extremity. Interbrachial arcs very wide and rounded. Abactinal surface slightly inflated. Actinal surface subplane. Marginal plates conspicuous but not tumid, forming an even border to body. Rays and disk perfectly rigid. Pedicellariæ present only on actinal surface.

The 2 series of marginal plates are not precisely opposite, plate to plate, on ray, but very nearly so. The superomarginals, 13 in number from median interradial line to extremity of ray, are much broader than high on disk and inner two-thirds of ray, but on outer third of ray the height and width become more nearly equal. The abactinal surface of the plates slopes gently off in a sort of bevel and meets the low lateral face, which is perpendicular. In the interbrachial arc the plates are only slightly wider than long, the length very gradually diminishing as they approach extremity of ray. Abactinal surface of each superomarginal has a large roundish bare space, the lateral face of plate being covered with low roundish granules, which decrease in size toward the margin and likewise surround the abactinal naked area in 1 or 2 peripheral series. On outer half of ray the bare space encroaches more and more upon lateral face, until the last 6 plates have only a marginal series of bead-like granules. The granules are low and sunk into a very thin membrane, and those of the peripheral series are slightly smaller than the others. A small, spatulate, two-jawed pedicellaria is present between 2 of the proximal plates.

Inferomarginals equal the superomarginals in number, but are slightly larger. They are much broader than high, encroaching more upon actinal area than do the dorsal marginals upon the abactinal. Plates are covered with granules similar to those of superomarginals, there being a small round naked area in the center of the actinal face of each, smaller in size than the corresponding areas on dorsal series. The outer 3 or 4 plates have only a single series of peripheral granules, the general surface being naked. Terminal plate large, short, and armed with a heavy thimble-shaped tubercle.

Abactinal area paved with small, roundish plates compactly placed, small papulæ issuing between them, except on a limited area in interradial region, where they are absent. Papulæ are single, and 4

or 5 are grouped about each plate, any papula being common to 3 or 4 plates. Secondary plates, of somewhat smaller but not uniform size, are scattered without order among the other plates, being most numerous on interradial areas, and on disk; not so common on rays. Each of the larger (primary) plates bears 1 to 4 (usually 2 or 3) subglobose low granules in the center, surrounded by a peripheral series of 7 to 10 similar, but usually somewhat larger ones. The smaller plates bear usually 3 to 6 granules, according to their size. The granules appear as if immersed in a very thin membrane, which, however, does not extend from plate to plate. Over a narrow interradial area (the radial papular areas being wide) the plates are often quite irregular. They are usually roundish to subquadrate. Many of them bear on the margin a small, upright, two-jawed spoon-shaped pedicellaria about the size of the granules. The jaws are often curved like bull-dog forceps. They are less common on the basal portion of the radial areas.

Adambulacral plates have a straight furrow margin, and are nearly as wide as long, the outer margin being often irregularly angular. Armature as follows: (1) A furrow series of 6 (5 on first few plates) short, stout, blunt, nearly untapered, cylindrical to faintly 4-sided, and not very uniform spinelets. The adoral spinelet is slightly the heaviest. The 6 are subequal in length or slightly graduated toward the aboral end of series. Occasionally the central 4 are a trifle weaker than the laterals, which may also be rarely a trifle shorter. (2) On the actinal surface 2 longitudinal series of granules immersed in a delicate membrane, which makes them appear shorter, in the undried state, than they actually are. The first series is well spaced from furrow spinelets, and consists of 3 or 4 subconical granules in a fairly straight series. On outer third of ray one of these enlarges into an upright, thick, cylindrical, tapering, sharp spinule, increasing in size toward extremity of ray. The granules of the outermost series are a trifle smaller, 5 or 6 in number, and follow the border of plates. When the latter is angular, an intermediate granule is often present between the 2 series. On the outer, spiniferous plates there are usually 3 rows of granules, irregular.

Mouth plates are large, with truncate outer ends, and a long furrow margin. The combined pair are prominent actinally, with a broad median suture. Furrow margin very nearly equals length of median suture. Armature as follows: (1) 10 short, stout, spinelets, 3- or 4-sided, blunt, shorter than adambulacral furrow spinelets, and not uniform as to form and length. Innermost spinelet is abruptly enlarged into a tooth; sometimes flattened, or slightly tapering, stout. (2) On actinal surface are numerous granules similar to those of adambulacral plates, a rather definite series being present along the margin of median suture, the innermost member of which is abruptly enlarged into a stout tapering prismatic spinelet. A row parallel with the furrow series, well spaced from it, is continued along the margin adjacent to first adambulacral, to meet the superficial series at its outer end. On the triangular area thus enclosed are 2 or 3 granules. All are invested by a very thin membrane which is hardly noticeable.

Actinal interradial areas are large, paved with large, irregular, quadrate to hexagonal plates, which decrease in size toward the margin. These plates extend two-thirds the length of the ray or to seventh inferomarginal. The plates adjacent to adambulacrals are largest and most regular. All are covered with low subglobular granules, a peripheral series being apparent by their more regular arrangement and slightly smaller size.

Madreporic body is large, subcircular, and is situated a trifle more than one-third the distance from the center to margin. Furrows or striations are narrow, irregular, inconspicuous, and interrupted.

Anal opening is subcentral, prominent.

Ambulacral furrow is very narrow, the tube feet with large sucking disks.

Color in life, pinkish buff; in alcohol, a bleached yellowish white.

Locality: Station 4151, vicinity of Bird Island, 800 to 313 fathoms, fine coral sand, foraminifera, stones; bottom temperature, 37.8°. Estimated that the trawl took bottom at about 800 fathoms depth, and was dragged up steep slope. Type no. 21164, U. S. National Museum.

This species appears to belong to that section of *Tosia*, called *Ceramaster* by Professor Verrill, characterized by having "all the plates above and below usually granulated nearly or quite all over, unless rubbed; in some species the marginal plates may often have a small, naked, central area. Adambulacral plates with 4 to 6 furrow spines." (Op. cit., p. 161.) This subgenus is mainly Atlantic in distribution.

Genus ASTROCERAMUS, new.

Type *Astroceramus callimorphus*, new species.

Resembles *Iconaster* Sladen (type *Astrogonium longimanum* Möbius) in general form, but differs in the following respects: Marginal plates centrally beset with rather coarse deciduous granules; third superomarginal (at base of ray) conspicuously larger than rest of series; abactinal plates bordered by small, simple granules, not by "very peculiar valve-like plates" (Sladen); actinal intermediate plates bear numerous tubercular granules; adambulacral plates of fair size, the furrow armature consisting of 5 rather stout, untapered, somewhat compressed, roundly truncate spines which are about as long as the furrow margin of the plate. The 2 median spines are slightly the larger, or 4 are subequal and nearly parallel. The adoral spine is nearly always conspicuously shorter than the others. On actinal surface of plate is a series of 2 stout, blunt, erect, cylindrical, or swollen spines more robust and slightly shorter than the furrow series, while on the outer portion of the plate are 7 to 11, stout, irregular or thimble-shaped granules, often angular in drying, simulating 2 longitudinal series, those nearest the actinal spines largest. Rarely a plate bears a large, two-jawed, spatulate, serrate pedicellaria. Similar pedicellariæ occur on the actinal intermediate areas.

It will be seen that this adambulacral armature is considerably different from that of *Iconaster*, whose adambulacral plates are small, the furrow spinelets being small and squamous, and the actinal of about the same size and disposed in several series (*I. longimanus*, Dujardin and Hupé, Hist. Nat. des Zooph. Echin., 1862, p. 397, under *Astrogonium souleyetii*). In *Iconaster pentaphyllus* (Alcock) also the adambulacral plates are small, with a semicircular furrow series of 10 or 11 small foliaceous spinelets in the basal half of ray and 8 to 6 in apical half, of which those at ends of series are thickened; while actinally there are 3 irregular longitudinal rows of depressed granules.

The character of the superomarginal plates is, I believe, one of importance. The granules surrounding the abactinal plates of *Astroceramus* can not be construed into "very peculiar valvular plates," since they are not plates at all. In *Astroceramus* the marginal and actinal plates are granular, not smooth as in *Iconaster*.

Astroceramus callimorphus, new species.

Pl. XXIII, figs. 1–3; pl. XXVII, fig. 3.

Rays 5. R=82 mm.; r=24.5 mm. R=3.35 r. Breadth of ray between second and third superomarginal 15.5–18 mm.; between third and fourth 12.5–15 mm.

Rays long and tapering, rigid, fairly slender after the basal expansion is passed; extremities pointed. Interbrachial arcs widely rounded. Lateral walls thick and massive, nearly vertical, but distinctly concave along the sutural line between upper and lower series of plates. Abactinal area plane; actinal subplane.

Abactinal area covered with large, flat, naked plates, irregularly polygonal. Those of radial and either adradial series are subcircular or hexagonal in outline, and are more regular than the others. Those plates of the interradial triangles are usually irregularly 5- to 6-sided. All decrease in size as they recede from the center, the largest plates being those of the primary apical system. All these plates are confined to the disk, except 4 or 5 small quadrate plates isolated between superomarginals near base of ray. These small plates are separated from one another and alternate with the superomarginals. Abactinal plates are surrounded by a series of small, oblong or quadrate granules, flat-topped and set flush with the general surface. The outer free edge of the granules is sometimes rounded. The general surface of plates is plane, or very slightly convex, free from granules, but roughened by minute bosses. In spaces between the plates small papulæ may be seen, although they are absent from a small triangular interradial area (the outer side of which is bounded by the interradial pair of superomarginal plates).

Marginal plates are massive and tumid, the upper and lower series not exactly corresponding on the ray. The superomarginals, 19 in number from median interradial line to extremity of arm, are much broader than high, and form a wide margin to body. Their outer free angle is abruptly rounded, and the length of each plate is about two-thirds to three-fourths the greatest width when the animal is viewed from above, but on the outer part of ray the 2 dimensions are nearly equal. The plates decrease in size both ways from third superomarginal. Tumid portion of both dorsal and lateral surfaces is covered with scattered, low, round granules, which leave a wide, perfectly free area

about the periphery of the plate. On outer part of ray these granules are fewer in number and are confined to the rounded edge of the ray. Margin of each plate is bordered by a series of small bead-like granules, smaller than those of the dorsal plates.

Inferomarginal plates correspond in number to superomarginals, and have about the same general dimensions, except that first and second inferomarginals are the largest of series. Ornamentation is the same as that of superior series, but the peripheral granules are larger. At inner edge of 3 or 4 plates near base of ray (about fourth to seventh inclusive) is a 2-jawed spatulate pedicellaria, like those of the actinal intermediate plates (q. v.).

Adambulacral plates are wider than long, with a faintly convex margin to furrow. Armature as follows: (1) A furrow series of 5 rather stout, untapered, somewhat compressed, roundly truncate spines which are about as long as the furrow margin of plate. These spines are not so obviously compressed on outer portion of ray and are there somewhat tapering. The 2 median spines are slightly the longer, or 4 are subequal and nearly parallel. The adoral spine is nearly always conspicuously shorter than the others, rarely tapering, and set at an angle with the rest of the series. (2) On the actinal surface, spaced a little from the furrow series, a longitudinal row of 2 short, blunt, erect, cylindrical or swollen spines, more robust, and slightly shorter than the furrow spines. This series decreases to a single spine, on the outer third of ray. Occasionally 3 spines are present in the series. On the outer portion of the plate are 7 to 11 stout, irregular or thimble-shaped granules, often angular in drying, irregularly placed or simulating 2 longitudinal series. Rarely a plate bears a large 2-jawed spatulate pedicellaria like those of actinal intermediate plates. One or 2 small, robust spinelets usually stand on the adoral margin near the furrow, forming a sort of continuation of the furrow series. The short adoral furrow spine appears to be one of these moved to the furrow margin. On the aboral edge there is sometimes a similar spine near the furrow.

Mouth plates are rather large but not especially prominent. Each plate forms a wide isosceles triangle, the base toward median suture. Free margin extensive. Actinostome very small. Armature as follows: (1) A furrow series of 7 stout, flat, truncate, or roundly tipped spines, increasing in length toward the inner angle. Some of the spines show a tendency to become prismatic. The plane of flattening is transverse to furrow. The inner spines are conspicuously enlarged and vary somewhat in shape. They are compressed to a thin blade with a truncate tip, which is broader than the base, so that the spine resembles a long hatchet-blade. At one mouth angle, however, the 2 teeth are not conspicuously widened. (2) On actinal surface, a superficial row of tubercles and spines present along the margin of median suture. The inner 2 are heavy, subprismatic, blunt. Rest of series (4 to 5) are blunt, irregular, subprismatic tubercles, or large granules, similar to those of adambulacrals. One inner spine and 2 or 3 tubercles form a similar series along the margin adjacent to first adambulacral. All are rather widely spaced.

Actinal interradial areas are large, and extend to fourth inferomarginal (in 1 ray to sixth). Small, isolated, intermediate plates extend on 1 ray as far as seventh inferomarginal. Intermediate plates are large, irregularly 4- to 5-sided (rarely hexagonal). The series adjacent to adambulacral is largest; all decrease in size toward margin. Each plate is surrounded by a series of unequal, bead-like granules, and on the general surface there are 1 to 5 larger, thimble-shaped granules, scattered irregularly and widely spaced. Many of the plates adjacent to the adambulacrals, as well as 1 to 3 others in the interbrachial region, bear a single, large, 2-jawed, spatulate, tongs-like pedicellaria. Each jaw has a distal expanded portion with a curved, serrate edge, and a narrower pedicel which again expands at the base to be inserted into a special slit. The special depressions for the jaws when opened are shallow. Five pedicellariæ have 3 jaws each.

Madreporic body is inconspicuous, irregularly hexagonal (shield-shaped), surrounded by 3 large plates. It is situated one-third distance from center of disk to extreme margin. Striations are of medium size, irregularly radiating.

Anus subcentral, small, surrounded by enlarged granules.

Tube feet with large sucking disks. Ambulacral furrow narrow and arched over by the armature of adamulacral plates.

Color in life not taken; in alcohol, bleached yellowish, with a pinkish cast on superomarginals.

Locality: Station 3857, Pailolo Channel, between Molokai and Maui islands, 127–128 fathoms, fine sand, yellow mud; bottom temperature 62.5°. One specimen, type no. 21165, U. S. National Museum.

Genus CALLIDERMA Gray.

Calliderma Gray, Proc. Zool. Soc., 1847, p. 76. Type, *C. emma* Gray, P. Z. S., 1847, p. 77; Ann. N. H., vol. xx, 1847, p. 198.

Calliderma spectabilis, new species.

Pl. xxiv, figs. 1, 2; pl. xxv, figs. 1–3; pl. xxvi, fig. 3.

Size large; form pentagonal, the angles prolonged into rays, the outer attenuate portion of which is formed by marginal plates only. General form depressed, flattened, abactinal surface subplane to slightly convex. Interbrachial arcs are very wide, the interradial portion of the margin of disk being straight and passing gradually into the rays, which have thus a broad base and taper rapidly into the elongated slender outer portion, the distal 20–26 superomarginal plates of adjacent sides being in contact medially. Disk is very large in proportion to rays. R=202 mm.; r=85 mm. R=2.37r.

Marginal plates are well developed, forming a stout border to disk, but relatively not so large as in *C. emma*. Plates of upper and lower series do not exactly correspond in number, nor are they exactly opposite, except sometimes for a short distance on either side of the interradial line. Throughout most of the ray they are usually alternate, the suture between them having a zigzag course. Edge of disk is square-cut on both surfaces, the lateral surface of the plates sloping inward toward the suture between the 2 series, so that the lateral face of disk and rays is concave or like a shallow V-shaped trough.

Superomarginal plates are broader than high and about as high as long. In interbrachial arc the outer margin of each plate is often slightly shorter than the inner, but the plates are irregular in this respect. Surface of plates subplane to slightly convex. There are 90 to 94 to each side of the body (more numerous in the largest specimen; 77 in a medium small specimen). General surface is covered with numerous, crowded, low, round, flat-topped granules, a marginal series being usually distinguishable. Granules of the latter become subconical along the margin adjacent to inferomarginals, and those of the lateral face of plate are more rounded than on dorsal surface. On the angular margin, where lateral and dorsal superficies meet, each plate bears 2 to 4 stout, short, tapering, very sharp spinules in a longitudinal series, and they extend along the ray to within 4 or 5 plates of where the 2 series of superomarginals meet medially. Throughout rest of ray they are absent.

Inferomarginals are slightly larger than the superomarginals, and also a little higher, their width on the actinal surface being greater than that of the superomarginals on the abactinal. They form a raised border to the ventral surface. The free margin is rounded on the outer part of ray. General surface is covered with flattened granules, similar to those of the dorsal marginals, but on the actinal surface these are rather more squamiform and subacute. The actinal surface is beset with prominent, tapering, occasionally slightly flattened, sharp, mobile spines, about 5 mm. in length, there being 12 to 20 to each plate. They are smaller and fewer in number on the outer part of the ray.

Abactinal surface is capable of some expansion. Plates are flat, hexagonal, and regular on the radial areas, a papular pore being situated at each angle of the hexagon. The papular area is widest in the basal radial area, constricting on the ray and toward center of disk, where there is a narrow circular papular area (bounded externally by the madreporic body) surrounding the anus. The large triangular interradial area is devoid of papulæ, and is paved with mostly 4-sided plates, which, like those of the radii, decrease in size as they recede from the center. They are covered with crowded, round, flat-topped or only slightly convex granules, larger than those of superomarginals. These granules increase in size toward the center of disk, and the centrally situated granules of each plate are slightly larger and usually more convex than are those at the sides. The plates of the radial papular areas are armed with larger, globular granules, one much enlarged, and often subconical, with 3 or 4 similar granules nearly as large grouped around it. Along the proximal portion of each papular area the plates of the 3 to 6 median longitudinal series bear each an erect, central, conical spine, as long or longer than the inferomarginal spines (5 mm.). In the type this spiniferous area is 50 mm. long by 15 to 20 wide. There are, besides, 5 stout spines around the anal opening. These abactinal spines are very characteristic and are more conspicuous in the medium-sized specimens than in the "giants," such as the type. The radial and either adradial row of spines are the longest and subequal; while a varying number of lateral shorter series is added at either side. Granules are often arranged in circles about the base of a spine, and the enlarged central granule of the other plates of radii is graduated in size in such a manner as to become smaller as it recedes from the spines. On the ray 3 to 6 granules larger than the others replace this central granule.

Adambulacral plates have a straight margin to furrow. The width of each plate is about two-thirds the length. The armed portion of actinal surface has the appearance of being more or less elevated above the level of the furrow margin. Armature as follows: (1) A furrow comb of 12 to 15 straight, untapered, slightly flattened, roundly tipped spinules, standing parallel. The proximal plates bear usually 12 spinules; those more distantly situated 14 or 15, while the plates at the tip of the ray only about 9. The lateralmost spinelets are shortest. A very characteristic feature of these spinules is that their tips do not conform to a straight or a regularly curved line, but rather to a compound curve. That is, the adoral half of the series is longer than the aboral, the exact relations showing better by figure than description. (2) The actinal surface of proximal plates bears about 6 erect, stout, tapering, sharp, movable spines disposed in 2 regular, or irregular, longitudinal series, or else without very definite arrangement. They average from 5 to 7 mm. in length. One of them is usually longer than all the rest, while frequently 1 or 2 others are not more than half as long as the longest. These actinal spines are reduced to 3 or 4 at about the middle of the radius, and to 2 on the outer attenuate portion of the ray. They are then arranged in an oblique transverse series, on the aboral half of the plate, the axis of the series running from the inner aboral corner to the middle of the outer edge. Proximal adambulacrals bear fewer actinal spines in medium sized and small individuals. Numerous large, irregularly subprismatic or squamiform granules are grouped about the border of each plate, except, of course, on the furrow margin.

Actinal interradial areas are very large, the intermediate plates extending along ray to nineteenth inferomarginal (from median interradial line) or to within 2 plates of the point where superomarginals of adjacent sides join medially. The plates are large, distinct, flat or slightly convex, irregularly 4 or 5 sided (occasionally hexagonal), those adjacent to the adambulacrals largest and most regular. All plates decrease in size as they approach the margin. They are covered with coarse, roundish, or subsquamiform granules, a peripheral series of smaller, closer ones being usually distinguishable. Each plate bears a central, sharp tapering prominent spine about 5 mm. in length. The plates adjacent to adambulacrals usually bear 2 or 3 in a transverse series, these being longer than the spines over remainder of interradial area. Likewise the proximal plates of the next 2 longitudinal series bear each 2 spines.

Mouth plates are small and narrow, the width of the united pair being equal to one-half the interradial dimension. Companion plates together form a sharp mouth angle with a long free margin. Marginal spinules 14, like those of adambulacrals, the innermost being somewhat enlarged and subprismatic. Actinal surface of each plate bears 8 robust, erect, sharp spines (like those of the adambulacral plates) in an irregular interradial row, with 1 or 2 odd spines in the corner adjacent to first adambulacral. There is great variation in the arrangement of these spines. Often there is a series of 4 parallel with the furrow margin, and a row of 3 to 5 extending thence to outer end of plate, decreasing in size outward. Margin of plate (excepting toward furrow) is lined with an irregular series of large, robust, subprismatic, or often subspinose granules. The odd actinal interradial plate adjacent to the outer end of the combined mouth plates bears 6 to 9 spines.

Madreporic body is circular, convex, with irregular striations. It is situated near the center of disk, about 12 mm. from anal opening (one-seventh distance from center to edge of disk).

In a medium-sized specimen examined the abactinal plates of the radial and either adradial series are distinctly 6-lobed. The other plates of the papular area, on either side of these, rapidly lose the lobed character. Near the primary radial plates the lobes become detached and form internal short radiating ossicles (4 to a plate) joining neighboring plates. The lobed plates touch each other by the lobes, usually only 4 lobes (2 on either side of plate) being sufficiently enlarged to impinge regularly on those of laterally situated plates. Each radial plate is thus joined to 2 adradials on each side. There are 5 large polian vesicles, and 5 conspicuous, distally bifid intestinal cœca. Interradial septa single, uncalcified.

Color in life: Abactinal surface bright cadmium yellow except the radial papular areas, and a circular area about the anus (bounded externally by the madreporic body), which are bright madder pink. The erect spines are whitish. Dorsal surface of superomarginal plates, except on outer third of ray, madder pink. The abactinal area of pink is lanceolate in shape, and about the border grades into the yellow area. The enlarged granules here are pink, while the rest of the plate is yellow. Many of the granules are deeper colored than the general tint. Actinal surface whitish.

Variation and young: This species is subject to a certain amount of variation which appears to be mainly due to age. There is represented in the collection every gradation in size from the smallest,

with a major radius of 32 mm., to a giant with major radius 217 mm. The principal difference in general shape is a more rounded interbrachial arc in the young, which gives a greater prominence to the ray. The adults have a large, heavy disk and relatively less prominent though not shorter rays. The spinulation of superomarginals is weak or lacking in the small individuals, but the erect spines on the abactinal plates are often rather more conspicuous, though not necessarily so numerous. These abactinal spines are well developed in all specimens, and are thoroughly characteristic of the species. On account of the more reduced disk in small specimens, the radial papular areas with their special armature and larger granules are rather more extended than in medium-sized and adult specimens. Young examples also have fewer adambulacral spines, both furrow and actinal. Inferomarginal spines are much fewer in young. The following table records a few of the more important differences due to age. Not all specimens are here noted.

Table showing variation of specimens.

Station.	Major radius.	Minor radius.	Number of superomarginal plates to side.	Number of superomarginal plates in contact on ray.	Abactinal spines to each radial area.	Adambulacral armature.		Inferomarginal spines.	Superomarginal spines.
						Furrow spines.	Actinal spines.		
	mm.	*mm.*							
4077a	32	13.5	31	11	Well developed	7–8	2–3	3–4, short	Absent.
4077b	47	16.5	45	18	do	8–10	2–3	3–5	A few tubercular granules.
4077c	51	18	48	18	28–30 to each radius; 2–2.5 mm. in length.	8–10	2–3	3–5	Do.
4077d	56	19	50	18–19	do	8–10	2–3	4–6	Nearly absent.
4077e	59	20	50	18	do	8–11	2–3	4–6	Scattered conical tubercles.
4077f	66	23	54	19	do	9–12	2–4	5–10	2–3 conical tubercles.
4077g	68	22	54	20	do	7–11	2–3	5–10	Do.
4098	74	24	64	24	Very well developed, 50–55 in each radius.	8–12	2–4	5–10	2–4 conical tubercles.
4077h	85	27	64	24	18–20	9–12	2–4	5–10	2–4 poorly developed tubercles.
4077i	87	30	60+	22	30–35	9–12	2–4	5–10	2–3 spinules.
4077j	90	30	68	24	35–38	9–12	2–4	5–11	Do.
4098a	103	37	74	24	25–38, large	8–13	2–4	5–11	Do.
4077k	135	45	92	31	20–22	9–14	2–4	5–13	Do.
4077l	143	55	96	31.5	45–55	8–13	2–5	Maximum 15.	2–4 spinules.
4077m		65			50, average	9–15	2–5	Maximum 15.	Mostly 4.
3938, type	202	84	90–94	[a]23	43, average	9–15	2–7	Average 12–20.	2–4 larger spinules.
4102	217	95	106	[b]29	25–40	Max. 15	2–8	Average 15–30.	Do.

[a] Arm tip injured. [b] Arm tip gone.

Localities: Type (no. 21166, U. S. National Museum) from station 3938, vicinity of Laysan Island, 148–163 fathoms, white sand and broken shells; bottom temperature, 60.3°. Taken also at the following stations, in all, 20 specimens:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3838	South coast of Molokai Island	92–212	Fine grayish-brown sand.
4074	North coast of Maui Island	78–85	Coral sand, foraminifera.
4077	do	99–106	Fine coral sand.
4079	do	143–178	Gray sand, foraminifera.
4098	do	95–152	Coral sand, foraminifera, rocks.
4102	do	122–132	Fine gray sand, foraminifera.

This is the most striking species taken by the expedition, and is remarkable alike for its beautiful coloring and the large size of mature individuals. It is apparently rather common on sandy bottom between 78 and 178 fathoms.

Calliderma may be distinguished from other genera of the Goniasterinæ by the prominent, mobile spines on the ventral plates, as well as by the broad disk, and attenuated rays, composed only, on the distal part, of the marginal plates. From its only known living congener, *Calliderma emma* Gray,

the present species is distinguished principally by the erect and prominent spines of the radial series of the abactinal surface of disk. The following differences may or may not be constant: *C. spectabilis* has rather narrower and more numerous superomarginal plates, more prominent adambulacral spines (both series), and the superomarginal, inferomarginal, and actinal intermediate spines appear rather large. *Spectabilis* is undoubtedly closely related to *emma*, which hails from Japan. When described by Gray the locality of this species was unknown, but a specimen was subsequently found in a bottle of insects from Japan. (Perrier, Rév. Stell., p. 226.)

Genus CALLIASTER Gray.

Calliaster Gray, Ann. N. H., vol. VI, 1840, p. 280. Type, *Calliaster childreni* Gray.

Calliaster pedicellaris, new species.

Pl. XXVII, fig. 1; pl. XXVIII, figs. 1, 2; pl. XXXI, fig. 1.

Rays 5. R=75 mm.; r=25 mm. R=3 r. Breadth of ray between second and third superomarginal plates, 18 mm.; between fourth and fifth, 13 mm.

Rays rather long and narrow, very gently tapering to a blunt extremity, the distal superomarginals being in contact medially. The rays appear of nearly uniform width after the somewhat abrupt basal expansion is passed, although they taper slightly. Interbrachial arcs widely rounded. Lateral walls thick, vertical, abactinal surface slightly convex on disk. Disk and rays very rigid and hard.

Abactinal area is narrow on rays, being narrower beyond the fourth superomarginal than the width of a single superomarginal plate. On outer part of ray abactinal plates are reduced to a single series, the plates being separated one from another by the superomarginals, which meet in the median radial line. Abactinal plates are large, irregularly circular, those of median radial series being slightly the largest and somewhat lengthened transversely on basal portion of radial area. The plates of interbrachial angle are not so regular. On central portion of disk there are numerous small plates scattered among the larger. These are arranged in more or less of a definite circle around each "radial" plate of the primary apical system, and also partially encircle a few neighboring plates. Each primary "radial" plate bears a thimble-shaped tubercle, which is repeated on 3 succeeding plates of the median radial series, thus making a longitudinal row of 4 tubercles on the proximal portion of each radial area. Unfortunately, with the exception of a single tubercle, these are all broken from the unique specimen. The scar seems to indicate that they decrease in size outward. The other abactinal plates, with the exception of a few in interradial area which are flat, have exposed surface slightly concave, and bear in the center a low round granule often set in a special shallow pit with slightly tumid edges. Margin of all plates is surrounded by an irregular series of small, poorly defined, low, flat topped granules, either roundish or elongated. They lie flush with the level of plates and are more or less sunk in membrane, which is visible between the plates. Occasionally there are 2 or 3 series of granules, always irregular. In interspaces between the plates small papulæ may be seen.

Marginal plates are massive, forming a broad, solid border to disk and rays. Each plate is distinct and tumid. The superomarginals, 15 to 16 in number from median interradial line to extremity of ray, are broader than high, and the length is about four-fifths of the chord of extreme width. They very gradually decrease in size toward extremity of ray. The 4 or 5 distal plates of each ray are in contact medially, while 4 to 6 plates centrally from these may touch by their inner edges, segregating 1 to 4 quadrate, abactinal plates. Each plate bears in the center, on the exposed tumid portion, a rigid, blunt, tubercular spine or elongated thimble-shaped tubercle which decreases in size toward tip of ray, and on the last 4 or 5 plates is reduced to a small granule (or may occasionally be wanting). The general surface of plates is smooth, except for a group of 2 to 6 small granules, just under the spine, on plates of interbrachial arc; and the margin is surrounded by an irregular, usually double, series of small, elongate, flattened granules similar to those encircling the abactinal plates. Terminal plate is large, with 3 spinules.

Inferomarginal plates are usually opposite superomarginals, to which they correspond in number. They are similar in character to the superomarginals, are tumid, and bear, each, a short, robust, blunt spine on the ventro-lateral face. On the first 3 plates there is also a similar spine on the lateral face, in a transverse series with the first. The first 4 or 5 plates have a few scattered granules in an irregular group on the lateral face, above the spines, and a similar group on the first 2 plates below the inferior

spine. The plates are also surrounded by a series of granules, similar to but larger than those of the superomarginals. Occasionally this series is incompletely double, especially along the lower margin.

Adambulacral plates are considerably broader than long, and the actinal surface is slightly raised above the level furrow margin (i. e., when animal is viewed from below). Armature as follows: (1) A furrow comb of 9 (or 8) spines, the lateral members of which are usually shorter than the other 7, which are subequal, parallel, about as long as the plate, round-tipped, slightly compressed, and untapered. The adoral end of each series overlies the aboral end of the adjacent series toward mouth. (2) On the actinal surface 2 thick, robust, cylindrical, blunt or truncate spines disposed in a transverse row. These may be very slightly tapering, and are about as long as the width of a plate. Margin of plate is surrounded by a single series of large, bead-like granules, and there are also 2 or 3 granules on the general surface of the plate.

Mouth plates are not prominent, but of fair size, elongate. The united pair form a regular projecting angle, with a long free furrow edge. Each plate is a low isosceles triangle in shape, the base to the median suture. Armature as follows: (1) A furrow series of 9 spines, the outer 6 of which are like those of the adambulacral plates and increase slightly in length toward the inner angle. The 3 inner spines are much larger and heavier, and increase in size toward the inner angle, the innermost tooth being blunt, heavy, and flattened on the actinal surface. There are thus 6 teeth at each mouth angle. (2) On the actinal surface one heavy spine, like the corresponding spine of adambulacrals, situated at about the center of plate; and a much smaller spine standing in line with it, toward the inner angle. The latter varies in size. Several large flattened granules occur near this spine. Along the edge adjacent to first adambulacral, and on outer half of median suture margin (i. e., behind the big spine) are numerous (12 to 14) large irregular granules in an irregular series.

The actinal interradial areas extend as far as the fourth inferomarginal. They are paved with large 4 to 5 sided plates, which are bordered by a row of prominent bead-like granules. Those plates adjacent to the adambulacrals are slightly convex, and as far as the third inferomarginal each bears a large 2-jawed pedicellaria, set in a special depression. Each jaw is broadly spatulate and rounded at the tip and when the pedicellaria is open fits into a special depression of the plate. Two or 3 other plates in the interradial region also bear a single pedicellaria, so that there are 19 or 20 pedicellariæ to each actinal interradial area. The majority of other plates bear 1 to 6 bead-like granules on the surface, in addition to the peripheral series, and these are usually clustered to one side, leaving most of the plate smooth.

Tube feet have large sucking disks. Ambulacral furrow is very narrow, entirely closed over by the furrow armature. Anal aperture is subcentral, very small.

Madreporic body is flat, circular, larger than any abactinal plates; situated midway between center of disk and inner edge of superomarginals.

Color in life: Abactinal area between chocolate color and Mars brown; superomarginal plates chocolate; spaces between abactinal plates in central portion of disk much darker, showing the plates in relief. Actinal surface buff pink, excepting large spines and adambulacral plates, which are cream color. Color in alcohol, dull brown, lighter beneath.

Locality: Station 4100, Pailolo Channel, between Maui and Molokai Islands, 130 to 151 fathoms, coral sand, shells, foraminifera; bottom temperature, 61°. One specimen, type no. 21167, U. S. National Museum.

This remarkably beautiful starfish evidently belongs to the genus *Calliaster*, although the other 2 known species are devoid of pedicellariæ. This feature alone will serve to distinguish the present form. It is also characterized by the following details of structure: The rays are longer and narrower than in the other species, with several distal superomarginals in contact medially; abactinal spines are fewer; superomarginal spines fewer and larger; actinal adambulacral spines 2 and very large; furrow comb of 8 or 9 spines; no enlarged tubercle on actinal intermediate plates as in *baccatus*. There are numerous minor differences which are appreciated by a comparison of figures. *Calliaster childreni* comes from Japan, *C. baccatus* from Simon's bay, Cape of Good Hope, 5 to 18 fathoms.

Genus GILBERTASTER, new.

Type *Gilbertaster anacanthus*, new species.

Form stellate, with a broad, slightly convex disk and wide, rounded interbrachial arc. Marginal plates prominent. No spines on abactinal, marginal, or actinal plates. Pedicellariæ very large and bivalved.

Abactinal plates flat, roundish, or not very regular polygonal in shape. A definite medio-radial row can be distinguished, the other plates being arranged in more or less parallel series, decreasing in size toward margin and tip of ray. Each plate is covered with large, close-set, flattish, very irregular valve-like granules, those about the border being smaller than the centrally situated ones. Scattered over disk and basal portion of rays are many large bivalved pedicellariæ, which are oblong in shape when viewed from above. Conspicuous papulæ emerge singly from sutures between the plates and are generally distributed except at end of ray.

Marginal plates are conspicuous, numerous, devoid of either spines or pedicellariæ, somewhat convex. They are covered with rather large, flat, round, hexagonal or irregular granules.

Adambulacral plates massive, nearly quadrate, with a variable and irregular but not prominent armature. Armature as follows: (1) A furrow series of about 2 or 3 short, stubby, very robust spines, flattened in a horizontal plane, and with truncate or irregular tips. Middle spine is often shorter than the 2 laterals; or occasionally a very large bivalved pedicellaria stands at the margin in place of the spines. (2) On the actinal surface 8 to 12 large, irregular, depressed, spaced, quadrate and polygonal granules of different sizes, and arranged without constant order. When a suggestion of 2 irregular longitudinal series can be seen, the inner has much larger granules. Bivalved pedicellariæ frequently replace some of the granules. No prominent spines on the actinal surface of any of the adambulacrals.

Mouth plates narrow, and slightly convex actinally. Armature consists of about 5 robust furrow spines, the inner massive, blunt, and subprismatic, with flattened side to actinostome. The actinal surface is covered with granules similar to those of the adambulacrals.

Actinal interradial areas well developed, paved with large actinal intermediate plates arranged in not very regular series parallel to furrow. These plates are very irregularly subquadrate to polygonal, and are covered with heavy, quadrate, oblong, or roundish granules, the exposed surfaces of which are flat. The plates adjacent to the adambulacral are larger than the others, and each bears a large bivalved pedicellaria surrounded by a single series of granules. Other smaller pedicellariæ are scattered over the rest of the interradial area.

Madreporic body of medium size, subcircular, convex; situated one-third distance from center of disk to extreme margin. It has no striæ, but is perforated with irregular pores of conspicuous size.

Gilbertaster anacanthus, new species.

Pl. XXVII, figs. 2, 2a–2c.

Rays 5. R=65 mm.; r=22 mm. R=3r. Breadth of ray at base (between second and third superomarginals) 16 mm.; half way between base and extremity, 10 mm.

Rays rather long and narrow, tapering abruptly at base, and then very slightly throughout rest of distance to the blunt extremity. Disk of fair size and rays inflated. Marginal plates well rounded. No spines of any description on general surface of body. Very large, low, sessile, bivalved pedicellariæ, on actinal and abactinal surfaces but not on marginal plates.

Abactinal area is paved with close-set, flat, roundish, or not very regular polygonal plates. A definite medio-radial series can be distinguished, the other plates being arranged in more or less regular rows parallel with it, decreasing in size toward the tip of ray and margin of body. Each plate is covered with close-set, superficially flat, large, very irregular granules. Those about the border of plate are smaller than the centrally situated ones, and form a very irregular peripheral series. The central granules, 2 to 6, are elongate, roundish, or rarely polygonal, while many have grotesque outlines quite impossible to describe. On small plates in the interradial areas, there is usually only a single large central granule. The exposed surface of granules is usually very slightly rounded or convex. Scattered over the disk and basal portions of arms are many large bivalved sessile pedicellariæ, which are oblong in shape when viewed from above. They average 1.5 mm. in length and are most numerous in interradial areas, extending thence as a single series along either side of the ray, just adjacent to superomarginals. They are absent from the median radial series of plates except rarely near center of disk. Each pedicellaria is so large that it extends quite across its plate, occupying the greater part. An interrupted series of granules surrounds it. The jaws are faintly toothed or serrated on opposing faces. Those pedicellariæ half way between center of disk and margin are largest (attaining 2 mm. in length); the smallest are adjacent to superomarginals. Conspicuous papulæ emerge singly from sutures between plates, and are generally distributed except at the very tip of ray.

Marginal plates are conspicuous, with a gently convex surface. Upper and lower series are not precisely opposite on arms; sometimes alternate. Superomarginals, 22 in number from median interradial line to extremity of ray, do not encroach much upon abactinal area, but form a rounded bevel. They are nearly quadrate in the interbrachial arc, but are longer than high on proximal two-thirds of ray, gradually becoming higher than broad toward the tip. The edge of the plate toward the abactinal area is curved. On one interradius there is a small, odd interradial plate, wedged between first superomarginals at their upper ends, apparently quite abnormal. General surface of plates is covered with rather large, flat, round, hexagonal, or irregular granules which increase in size from center toward periphery. Although low, their general surface is very slightly convex, and is smooth. In interbrachial arc the granules of the peripheral series are conspicuously smaller than the others, but on the ray they may be large, owing to the fusion of granules of the first and second series, which thus form long granules, extending from the periphery toward the center. Often long and short granules alternate. Terminal plate is prominent, subspherical, prolonged on the inner and abactinal side, covered with scattered granules.

Inferomarginal plates are equal in number to superomarginals, and encroach rather more upon actinal area than do the superomarginals upon abactinal. The 4 median plates of interbrachial arc are the largest, with a curved margin toward actinal area. Covering of plates very similar to that of superomarginals. In one interradius there is a pedicellaria at outer and upper corner of the second inferomarginal. No others are present on either series of marginals.

Adambulacral plates are massive, nearly quadrate, with a variable and irregular armature. Furrow margin is nearly straight, but abruptly curved at either end of the plate. Armature as follows: (1) A variable number of furrow spines—usually 2 or 3—short, stubby, very robust, and flattened (in horizontal plane) with truncate or irregular tips. Middle spine is sometimes much shorter than the 2 laterals, even becoming reduced to an enlarged granule. Less commonly there are 4 spines, subequal or one much smaller. (2) First adambulacral plate has a giant pedicellaria (similar to those of abactinal surface) on the actinal surface but flush with the furrow margin, extending the whole length of plate and entirely superceding the furrow spines. Four out of the 10 second adambulacrals possess it also, but in this case a few additional furrow granules or irregular tubercles also are present. These pedicellariæ are also present on numerous other adambulacrals, but are not so large, and in all cases where present the furrow armature is in consequence reduced in size, usually to flattened upright granules or irregular spinules. Pedicellariæ occasionally are set obliquely on plate. Rest of actinal surface is covered with about 8 to 12 large irregular quadrate and polygonal granules of different sizes, and arranged without constant order. When a suggestion of 2 irregular longitudinal series can be seen, the inner has much larger granules. An enlarged granule with a swollen end is usually present just aborad to the end of the pedicellaria.

Mouth plates slightly convex actinally, the united pair rather narrow, with an extensive, angular, but rounded furrow margin. Armature stout, composed as follows: (1) Furrow spines 5, the inner massive, blunt, subprismatic, with flattened side to actinostome. The next two are shorter and weaker, flattened or prismatic, with a rounded tip. The 2 outermost are shorter still and thicker, not constant as to shape, usually irregular. (2) Actinal surface is covered with granules. A series extends along margin of median suture. These are largest, are flat, subquadrate, or pentagonal, irregular, and diminish in size abruptly at inner end of plate, the series terminating a short distance from the teeth. Another series follows margin adjacent to first adambulacral, and is continued inward parallel with furrow series, the latter portion containing a few compressed, upright, round-tipped granules, irregularly disposed. Several small granules are present between the inner ends of companion superficial series.

Actinal interradial areas well developed, paved with large actinal intermediate plates arranged in series parallel to ambulacral furrow. Those adjacent to adambulacrals are largest and most regular, being subquadrate save for the outer margin, which is usually angular or rounded. They extend to the fifteenth inferomarginal, or three-fourths length of ray, while other intermediate plates do not extend beyond basal fourth of ray, being smaller and irregularly polygonal in shape. The outer portion of the series adjacent to adambulacrals is interrupted by the inferomarginals touching the latter, thus separating the intermediate plates. On the ray these pedicellariæ are not present on every plate. Each is surrounded by heavy, quadrate, oblong, or roundish granules in a single series, with indications occasionally of an incomplete intermediate series of small granules between successive plates. There

are 12 to 15 pedicellariæ, about half the size of those already described, scattered over the remainder of the interradial areas, the plates of which are covered with closely placed, flat, irregular granules similar to those of abactinal plates. Granules surrounding pedicellariæ are raised slightly above the level of the others.

Madreporic body of medium size, subcircular, slightly convex, situated one-third distance from center of disk to extreme margin. Perforated with coarse, irregular holes; no striæ.

Color in life: Dull yellow on dorsal surface, brightest on marginal plates; central part of dorsal area with a brownish cast. Actinal surface a pale Naples yellow with a brownish suggestion.

Locality: Station 4041, west coast of Hawaii Island, 382–253 fathoms, gray mud, foraminifera; bottom temperature 41.6°. One specimen, type no. 21168, U. S. National Museum.

The peculiar large bivalved pedicellariæ of this species remind one very strongly of *Hippasteria*, but the absence of spines and the structure of the skeleton are more like *Tosia*. The very unusual flat ossicle-like granules are unlike those of any goniasterid with which I am acquainted. *Gilbertaster* appears to be allied to some of the Hippasterinæ, particularly to *Cryptopeltaster* from off the California coast. The latter genus is undoubtedly a member of the Hippasterinæ. I am inclined to regard the present form as intermediate between the Goniasterinæ and Hippasterinæ, and have consequently placed it provisionally at the end of the former subfamily. It might be considered with almost equal propriety an aberrent member of the Hippasterinæ.

This genus is named for Dr. Charles Henry Gilbert.

Subfamily HIPPASTERINÆ Verrill, 1899.

Hippasterinæ Verrill, Revision of Certain Genera and Species of Starfishes, with Descriptions of New Forms. <Trans. Conn. Acad., vol. x, 1899, p. 174.

Genus EVOPLOSOMA, new.

Type *Evoplosoma forcipifera*, new species.

General form that of *Hippasteria*, which it resembles also in the ossicles and spines; but the whole test (both ossicles and spines) is overlaid by soft fleshy membrane, which in life completely hides the outlines of plates. Abactinal and actinal pedicellariæ erect, with rounded spatulate denticulate blades.

Abactinal surface paved with small roundish plates, interspersed with still smaller roundish secondary plates, bearing smooth or rugose granules sheathed in pulpy membrane and erect rigid spines and spinules, the former partially encased in membrane, the latter wholly. Spines and granules on marginal and actinal plates of the same character as the abactinal. Furrow spines remarkably thin and compressed, especially adorally, 3 or 4 to the plate, and wi h expanded chisel-like tips. Actinal adambulacral spines very robust, curiously expanded at the tip, and often gouge-shaped; usually single with an accompanying large spatulate "sugar-tongs" pedicellaria.

While this genus is undoubtedly closely related to some species of *Hippasteria*, the persistent, and in life soft pulpy membrane which covers the whole test will serve at once to distinguish it. This membrane invests each granule individually, hiding the calcareous part and causing the granulation to have a crowded, soft, warty appearance. From this surface the conical spines and pedicellariæ raise themselves in a short bristling armature. The whole animal, as in *Hippasteria*, is very rigid. When the test is dried the membrane shrinks greatly, and the roughened granules are easily seen, then appearing separated. But in life this is not the case because the membrane investment fills up all the intervening space, causing the granules to appear very much larger. The high pedicellariæ are unlike those of typical *Hippasteria*, although easily derived from them by slight modification.

Prof. A. E. Verrill agrees with me that this species constitutes a new genus.

Evoplosoma forcipifera, new species.

Pl. XXVI, figs. 5, 5a–c; pl. XXVII, figs. 4, 4a–b; pl. XXIX, fig. 3.

Rays 5. R=56 mm.; r=24 mm.; R=2.3 r. Breadth of ray at base, between third and fourth superomarginals, 11 mm.

Disk large, pentagonal, inflated, narrowing abruply into slender, tapering rays, which end in a blunt point. Body bristling all over with short, stout, conical spines. Disk very distinct from rays, which appear as if attached to its corners. Integument stout; whole animal rigid. Marginal plates not distinct. Interbrachial arc very wide, straight, not curved in median portion.

Abactinal area conspicuously inflated about border, and paved with rather small round plates, among which are smaller secondary roundish plates. They are immersed in a tough membrane, and

the whole of the abactinal and actinal surfaces and marginal plates are covered with variously sized spiniform granules, each invested with a soft, thick, and pulpy membrane which completely hides the granules, giving the appearance of a crowded, soft, warty, irregular, granulation. These fleshy granules are round- or flat-topped, and so crowded that they press each other out of shape. They completely hide the outline of the abactinal plates. Scattered over abactinal surface are many short, stout, sharp, erect, conical spines, giving the whole surface a bristling appearance. The largest are 2 mm. long, and they decrease in size toward the margin. Scattered among them are many intermediate, sharp, conical tubercles of several sizes, evidently specializations of the immersed granules. The pulpy membrane rises upon the base of the spines, but is not evident toward the tip. Spines are arranged in 2 or 3 irregular rows on ray, and decrease very irregularly in size toward its extremity. Over all the disk except a very limited and narrow interradial region long, conspicuous papulæ emerge from the reticulated covering. They are scattered around the plates; absent from rays. On interradial areas of disk are a few large 2-jawed upright pedicellariæ. These are sunken in special pits, have broad, even, rounded, often notched, spatulate jaws, which, however, possess no especial depression into which they fit when opened.

Marginal plates are large, but not conspicuous. The 2 series correspond in number and are opposite. Superomarginals, 15 in number from median interradial line to extremity of ray, are confined to side wall of body in interbrachial arc, but encroach more and more upon abactinal areas as they proceed along the ray. On outer part of ray their breadth very nearly equals height. In interbrachial arc the length is a trifle greater than height (or width). Transverse sutures and that separating the 2 series are easily seen. The line of demarkation between the marginal and abactinal plates is not clearly evident. On disk the superomarginals bear 3 stout, rigid, sharp, conical spines, stouter than those of the dorsal integument, disposed in a transverse series on a median tumid portion of the plate. At base of ray these become reduced to 2, and on outer portion of ray to but one, which stands on a sort of boss where the lateral and dorsal superficies of the plate meet. First superomarginal usually has slightly shorter spines, and 3 or 4 of them are grouped in the center of plate, with a number of subsidiary conical granules surrounding them. A marginal series of rather regular, 4-sided to subcircular flattish, fleshy granules borders each plate—save the upper edge. Within this is a second series of larger spherical to subconical granules, less regular, surrounding the base of the tumidity which bears the spines. On outer portion of ray the transverse portions of second series of granules are absent. First and second plate usually have a pedicellaria similar to those of abactinal surface near the middle of the lower side just above the peripheral row of granules.

On disk the inferomarginals are slightly larger than corresponding superomarginals, are quadrate, about as broad as high, and form an evenly curved margin to actinal area, upon which they encroach. They are tumid like the superomarginals, the tumidity becoming more pronounced on ray, on the proximal plates of which are 2 (usually 3 on innermost plate of ray proper) rigid spines, similar to those of superomarginals, and similarly placed. On outer third or half of the ray these are reduced to a single spine. On first 3 inferomarginals there are 7 shorter spines, with several enlarged granules, scattered in an irregular quadrate group. Fleshy granules, like those of superomarginals, cover the remaining surface of the plates. The inner or lower edge of the plates is not evident superficially, the granules being continuous with those of actinal interradial areas. In one interradius there is a small pedicellaria, like those described for superomarginals, situated near the upper border of each of the 2 median inferomarginals.

Ambulacral furrow rather narrow. Outlines of adambulacral plates not evident superficially on account of the fleshy granules. Plates are slightly longer than wide, with a convex margin to furrow. Furrow spines are 6 on first plate, 5 on second, and 4 or 3 on the rest. They are long, stout, strongly compressed, with broad subtruncate or rounded tips. They resemble broad chisel or narrow hatchet-blades in shape, and become thinner toward the tip. Where there are 4 spines the aboral is shortest, and varies much in shape, resembling usually a wedge. The other 3 are subequal, or the median slightly the longest. Often a spine appears as if partially twisted on its long axis, or the broad spatulate blade may be a trifle concave on one face like a scoop. The 2 lateral members are usually broader at the tip than the median. In the middle of the actinal surface of plate stands a solitary, remarkably heavy, rigid, upright spine, shorter than furrow spines. Its base is cylindrical, but the end flares more or less, and the outer aboral face is concave like a gouge; the tip is rounded, subacute, or blunt. Frequently the tip appears somewhat 3-sided, one side concave, and the others flat or slightly rounded.

There is great variation in the details of this spine in the single specimen. On adoral side of plate, close to furrow margin, is a very large, upright 2-jawed pedicellaria, the valves being broad and shaped something like a pecten shell, only more irregular. Frequently the edge is notched, and one edge slightly concave, the other correspondingly convex. On the ray the pedicellariæ decrease in size, and are very broadly spatulate with a more contracted base than have those of disks. Outer side of plate is beset with 5 to 6 flesh-covered, irregular roundish or 4-sided granules, 1 or 2 of which, on the 4 to 5 proximal plates, are larger than the others.

Mouth plates large, but not prominent actinally. Plates are broad, the combined pair with an extensive and angular rounded furrow margin. Armature as follows: (1) A furrow series of 8 much flattened, abruptly round-tipped, spatulate spines, which become thinner toward the tip like a wedge. Their bases are united by a delicate web. They are more regular than the adambulacral furrow spines and a trifle smaller, except the inner 2, which are large, very broad, and hatchet-like. The innermost tooth is largest of all. (2) Back of furrow spines the actinal surface is bare for a short distance, the remainder of surface being covered with the characteristic granules, which are not crowded, and which increase in size toward outer end of plate. In center of actinal surface is a single upright pedicellaria, similar to, but smaller and slenderer than those of adambulacrals. First adambulacral is larger than the rest, with 6 furrow spines, and its actinal spine reduced in size. Actinostome small, entirely roofed over by the large spines.

Actinal interradial areas are large, forming a nearly equilateral triangle, bounded by the first 2 inferomarginals; a single series of intermediate plates extends, however, as far as the fifth inferomarginal. The plates are roundish and entirely obscured by the numerous compactly placed, round or irregularly polygonal skin-covered granules which shrink up when dried and allow the plates to be seen (pl. XXIX, fig. 3). From 30 to 45 stout, erect, rigid spines, smaller than those of the adambulacrals, and a trifle heavier than those of the inferomarginals, are disposed in irregular chevrons over interradial area with the exception of a small space immediately outside of mouth plates. These spines are short, conical, with grooved, 3- or 4-sided tips, much resembling some sort of a drill. When the specimen is dried they are seen to correspond, about 1 to a plate. The calcareous portion of the granules is rugose or roughened. A pedicellaria, similar to those already described, is situated near outer end of mouth plates, and another about the middle of interradial area.

Madreporic body small, convex, with coarse, convoluted striations; situated a trifle nearer center than midway between latter and margin of disk.

Tube feet large, with large sucking disks.

Color in life, pinkish orange.

Locality: Station 4186, east of Kauai Island, 682–508 fathoms; gray sand, foraminifera; bottom temperature 38.1°. One specimen, type no. 21169, U. S. National Museum.

This species is readily distinguished by the curious fleshy investment of all the granules of the body, as well as of the base of the spines. The photographic figure of this species is from the dried specimen, in which the membrane has greatly shrunken.

Subfamily LEPTOGONASTERINÆ Perrier, 1894.

Leptogonasterinæ Perrier, Exp. Scientif. du Travailleur et du Talisman, etc., Echinodermes, 1894, p. 252.

Genus ANTHENIASTER Verrill.

Antheniaster Verrill, Trans. Conn. Acad., vol. x, Aug., 1889, p. 173. Type, *Anthenoides sarissa* Alcock.

Antheniaster epixanthus, new species.

Pl. XX, fig. 3; pl. XXVI, figs. 1, 1a-c; pl. XXIX, figs. 1, 2; pl. XLIX, fig. 1.

Rays 5. R=90 mm.; r=47 mm. R=1.92 r. Breadth of ray, between first and second superomarginals, 47 mm.; between fifth and sixth, 25 mm.

General form is flat and depressed. Disk large, pentagonal, slightly inflated in most specimens. Rays short, broad, tapering, flat, acute, but not narrow-pointed. In smaller specimens the rays are much longer. Interbrachial arcs very wide, rounded or occasionally a trifle angular. Lateral wall, or margin, rounded-vertical in large specimens; rather angular in the interbrachial arcs of smaller specimens, but becoming vertical on outer part of ray, which is then quadrate in section. The whole animal is covered with a moderately thick, tough but soft membrane or skin, which obscures the out-

lines of most of the plates in the living and alcoholic specimens. When dried, the membrane shrinks very much, and on the dorsal surface reveals a sparse and very minute granulation. Granules of marginal and actinal plates are coarse and conspicuous in the dried state, but are not very conspicuous in the living or alcoholic specimens on account of the pulpy consistency of the skin.

Abactinal surface is subplane to slightly convex, covered with a wrinkled, rather thick membrane which reveals the plates beneath when dried. In each median interradial line there is a sharp crease extending inward toward center of disk, while similar lines extend toward center of radial area from each suture between superomarginals. Everywhere the skin is traversed by fine creases. Radial areas are conspicuous by the black papulæ which have passage at corners of hexagonal plates, and thus indistinctly mark out their form. Papulæ wanting on median interradial region. Plates are further revealed in fresh specimen by creases which radiate from papular pores. The fine granulation is not apparent in the undried state. Pedicellariæ wanting on dorsal surface. If the skin is stripped off (which is done with difficulty), the arrangement of plates is then easily seen; or the specimen may be dried. Plates are polygonal and rather irregular. A fairly regular series extends along median radial line, the remainder being arranged parallel to this. Median series does not reach tip of ray, the outer 6 or 7 superomarginals of either side being in contact medially. The other series do not extend so far as the median, but end one after another in conformity with the taper of the ray. External to median radial series on each side is an irregular series of much smaller plates which extend but a very short distance beyond the base of the ray, where they die out gradually. The plates of next series external to this are large as the median radial, and are adjacent to them after the disappearance of the smaller intermediate series. The third longitudinal series consists of even smaller and more irregular plates than the first or intermediate series. (This series is not apparent in largest specimens, and when present it does not extend so far distad as the other intermediate plates.) Fourth series as large as second. Opposite the fourth superomarginal one can count 6 or 7 longitudinal rows at either side of the median radial series. Occasionally the smaller intermediate plates form a partial series around the larger plates, but in this case they are smaller than the longitudinal series of intermediates. No definite arrangement over center of disk, which is paved with rounded or subpolygonal, large and small plates mixed together. Interradial plates are regular in type—hexagonal to quadrate—but may be irregular in smaller specimens. If abactinal area is treated with caustic potash and viewed from the internal (or coelomic) side, some of the smaller intermediate plates (not those of the longitudinal intermediate series, but still smaller plates) are seen to form short, connecting, radiating ossicles between larger plates of the median radial area at base of ray nearly to center of disk. Their arrangement is irregular, however, and some of the smaller plates of the disk are rudely substellate. This point is, however, not at all evident when the plate is viewed from the dorsal side. The so-called connecting ossicles appear merely as irregular small plates between the larger polygonal ones. In large specimens these smallest intermediate plates are scarce; and they are by no means constant in number or position in the medium-sized and small specimens. But the presence of an intermediate incomplete series of secondary plates at either side of the median radial series is constant.

Marginal plates are well developed. Superomarginals, 20 in number from median interradial line to extremity of ray, are wider than long, and form an arched border to body. In a few smaller specimens the inferomarginals extend laterally slightly beyond superior series on disk. In this case the superomarginals form more of an arched bevel. They are covered with tough membrane, in which are embedded 8 to 20 subspherical granules spaced over the central portion of plate. These are absent from outer half of ray. The first superomarginal is slightly shorter than succeeding 4 or 5.

Inferomarginals correspond in number to superomarginals, but are not always exactly opposite to them at base of rays. They are much broader than high, and encroach conspicuously upon actinal area, being covered with numerous scattered granules imbedded in membrane. These increase in size toward outer edge of plate, and are largest on the lateral face of ray, where they are as large or slightly larger than the granules of superomarginals and decidedly more numerous and close-set. Terminal plate prominent, pentagonal, armed with 3 terminal, thimble-shaped granules.

Adambulacral plates longer than wide, with a faintly convex furrow margin. Armature consists of 7 (occasionally varying to 6 or 8) short, blunt, slightly compressed spinelets, which form a radiating palmate series and are covered with membrane, which as a sort of web, unites them for a short distance above the base. Usually the end spinelets are much shorter than the median, the whole forming a rather regular graduated series. Actinal surface of plate, like remainder of body, is covered

with membrane, so that outlines of plates are wholly obscured except when in a dry state. (Compare figs. 1a and 1b, pl. XXVI.) A definite crease or line in the membrane runs from the furrow obliquely outward toward the margin of body. These wrinkles separate each adambulacral plate, and every second or third line is confluent with the suture between 2 interomarginals, while the intermediate lines end between the furrow and margin. Actinal surface of adambulacrals bears 6 to 8 subspherical granules of unequal size, disposed in an irregular longitudinal series along the middle of plate. They are covered by thick membrane and are not very conspicuous until animal is dry. (Pl. XXVI, fig. 1b.) On outer half or third of ray these are replaced by a single, stout, short, tapering spine, exceeding in length the furrow spinelets, which are here quite short. A few plates bear, near the adoral margin, between the furrow series and granules, a single rather long 2-jawed pedicellaria, about as long as the nearest furrow spinelet. Each jaw is narrow spatulate and curves slightly, like a pair of tongs, to meet its companion.

Mouth plates are large and prominent actinally, with a very extensive furrow margin. Furrow spinelets 11, stout, the outer ones similar to the adambulacral furrow spinelets, but the 2 or 3 inner larger and heavier. Actinal surface is armed with prominent granules, subspherical to thimble-shaped, arranged in an irregular series parallel to median suture, and another continuing the linear series of adambulacrals. Numerous much smaller granules are scattered here and there.

Actinal interradial areas are covered with membrane, which is lined with fine creases or wrinkles, as already noted. The plates are irregularly polygonal or roundish, and are arranged in chevrons, decreasing in size toward the margin. They bear a central group of subspherical or low thimble-shaped granules, the rest of exposed surface being beset with smaller, widely spaced granules. The series adjacent to adambulacrals usually bears 3 to 10 larger granules, the next series 3 to 6, and the other plates 1 or 2 such.

Madreporic body is large, hexagonal to subcircular, situated about one-third distance from center to extreme margin. Its exposed surface is flat and sunken a trifle below the level of the surrounding membrane except in the dried state. Striations fine, radiating.

Anal opening subcentral, surrounded by 5 plates larger than their neighbors. The aperture is guarded by about 8 tooth-like granules. Tube feet with large sucking disks.

Color in life: Dorsal surface deep cadmium yellow to cadmium orange; lower surface cream color to cadmium. In alcohol, dull light brownish to deep brown.

Variations: There appears to be a dimorphism in this species. Some specimens (in the majority) have longer, slenderer rays than others. Superficially they would be taken for a different species, but I am unable to find any other correlative character by which to separate them. The type specimen is neither the one extreme nor the other, but is rather short-rayed, however. The following table of measurements (in millimeters) will give an idea of the difference:

Measurements of specimens of Antheniaster epixanthus.

Station.	Major radius.	Minor radius.	Ratio.	Supero-marginals.	Width of ray between second and third supero-marginal.
	mm.	*mm.*		*no.*	*mm.*
3813	93	50	1.9—	17	43
4080 (type)	90	47	1.92+	20	40
4115	69	40	1.74	15	34
4080	96	42	2.3	19	35
4080	77	32	2.4	20	28
4081	90	35	2.57	22	29
4081	65	24	2.7	18	20

The presence of pedicellariæ on adambulacral plates is also subject to great variation. In the type there are only a few scattered along the base of ray, and on the largest specimen none are to be found. On the other hand, a medium-sized specimen of the long-rayed phase has 4 to 12 on each adambulacral series of disk. At first this might appear of specific value, but pedicellariæ are either very few or absent from all the other long-rayed specimens, except one which is intermediate between the extremes.

Localities: Type (no. 21170, U. S. National Museum) from station 4080, north coast of Maui Island, 178–202 fathoms, gray sand and foraminifera; bottom temperature 56.4°. Taken also at the following localities, a total of 13 specimens:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3813	South coast of Oahu Island	264–183	Coral sand, lava specks, shells.
4081	North coast of Maui Island	202–220	Gray sand, foraminifera.
4082	do	220–238	Do.
4084	do	253–267	Fine gray sand.
4115	Northwest coast of Oahu Island	195–241	Coral sand, foraminifera.

Anthenoides, *Leptogonaster*, and *Antheniaster* are very closely related. The arrangement of the dorsal plates appears to be essentially the same in the three genera, which are likewise characterized by a granulous membrane. The type of adambulacral armature of *Leptogonaster* is essentially that of the distal portion of the ray of *Antheniaster epixanthus*, and the pedicellariæ are strikingly similar, these being reduced to the elongate variety in *Antheniaster*. The dorsal membrane of the latter is not so granulous as in *Leptogonaster*, but is thicker, at least in the Hawaiian species. The mouth plates are prominent, but more heavily covered with membrane than in *Leptogonaster*, and likewise bear more granules. These three genera do not appear to belong under the Goniodiscidinæ, which are probably more nearly related (so far as *Goniodiscides* is concerned) to the Pentacerotidæ than to the typical goniasterids. I have accordingly placed *Antheniaster* in Perrier's Leptogonasterinæ. This subfamily, is of course, closely related to the Goniasterinæ, and not, as its author believed, to the Mimasterinæ or Odontasteridæ. I am indebted to Prof. A. E. Verrill for the generic determination of this species.

Subfamily GONIODISCIDINÆ, new name.

Goniodiscinæ Sladen, Challenger Asteroidea, 1889, p. 321. (*Leptogonaster* is excluded.)

Genus GONIODISCIDES, new name.

Goniodiscus Müller and Troschel, System der Asteriden, 1842, p. 57. Emended by Perrier, Révision des Stéllerides, 1875, p. 229. Type, sens. nov., *Goniodiscides sebæ*.

This genus is equivalent to that long known as *Goniodiscus*. Under existing rules of nomenclature *Goniodiscus* is untenable because it was proposed by Müller and Troschel to include previously described genera of Gray (*Anthenea*, *Nectria*, *Tosia*), as well as species unknown to Gray. If this group had really constituted a genus the oldest name, *Anthenea*, should have been used. Likewise the type (first species) of *Goniodiscus* is the same species, under a different name, as the type of Gray's *Anthenea*. Müller and Troschel included the following species under their *Goniodiscus: Pentagonulus* [*Anthenea*], *sebæ*, *placenta* [*Tosia*], *regularis* [unknown], *pleyadella*, *ocelliferus* [*Nectria*], *cuspidatus*, *mammillatus* [*Tosia*], *capella* [since made the type of *Ogmaster* v. Martens]. This left *sebæ*, *regularis* (?), *pleyadella*, and *cuspidatus*. *Goniodiscus* has subsequently been used for these species, but since the name was originally applied to a composite group and was a synonym as soon as made, it should be discarded for all time. As there appears to be no subsequent name[a] available, I propose *Goniodiscides*, with *Goniodiscides sebæ* as type.

Goniodiscides sebæ (Müller and Troschel).

Pl. XIX, fig. 3.

Goniodiscus sebæ Müller and Troschel, System der Asteriden, 1842, p. 58.

An example of this curious species, the first from the Hawaiian Islands, was taken by Mr. H. W. Henshaw at Hilo, on the windward side of the island of Hawaii. (Accession no. 42800, U. S. Nat. Mus.) No specimens were secured by the expedition of 1902.

[a] *Metopaster* Sladen (Monog. on Brit. Fossil Echinod. from Cretaceous, II, Asteroidea, pt. II. <Pal. Soc. Monog. 1893, p. 13) is near this genus, but is hardly identical, as has been claimed. (Valette, Note sur quelques Stellérides de la Craie Senonienne du Dép. de l' Yonne. <Bull. Soc. l' Yonne, LVI, 1902, p. 7.)

Concerning the capture of this specimen, Mr. Henshaw has sent me the following notes: "They are by no means rare in a small inlet some three miles south of Cocoanut Island. If I remember rightly, all I found were under stones in shallow water, two or three feet deep. In other words, so far as I observed it, it was a littoral, shallow water species." This is the only species of starfish, so far as I am aware, that may be collected along shore in the islands, unless *Ophidiaster lorioli* be excepted.

This specimen agrees very well with the original description of Müller and Troschel, and with the notes given by de Loriol (Mém. de Société Phys. et d'Hist. Nat. Genève, XXIV, 1885, p. 48). De Loriol also gives a good figure (op. cit, pl. xv, fig. 6) with which our example shows a few unimportant points of difference.

Form pentagonal, the sides of disk only very slightly curved inward. R = 29 mm.; r = 23.5 mm. R = 1.23 r. As noted by de Loriol there are 14 superomarginals to a side, or 7 to the "ray", instead of 6, as stated by Müller and Troschel. The ultimate plate of each series is very small, and is wedged between the penultimate and ocular plates. There are 9 inferomarginals to the ray, the last plate being very small indeed.

The superomarginals are somewhat tumid, and are broader than high. Besides the even, fine granulation, each bears from 2 to 10 conspicuous, low, hemispherical, or subconical, tubercular granules, unevenly disposed. Inferomarginals are similarly armed. There are no pedicellariæ on any of the marginal plates. Between the 2 series of marginal plates, on the lateral wall of the body, is a row of 5 to 7 pits, each of which occurs at the junction of a dorso-ventral with the horizonal suture.

Abactinal surface is covered with a much finer granulation than the actinal, and each plate is surrounded by 6 to 8 papular areas which appear in many cases practically confluent. These areas contain 8 to 20 pores, and a cuneiform area containing about 15 to 18 pores occurs between the dorsal ends of the superomarginal plates (excepting between 5 and 6 and 6 and 7). Each abactinal plate bears near the center 1 to 3 of the tubercular granules, a few of which occur also, here and there, over the papular areas. A number of plates toward center of disk bear small bivalved pedicellariæ similar to those of *Pentaceros* and flush with the general level of the granulation. These are not very numerous and are irregularly scattered, never more than 2 to a plate. The madreporic body is raised above the general surface and is situated about one-third the distance from the center to margin. About its border are several tubercular granules. The plates toward the end of ray and adjacent to superomarginals appear to be a trifle convex, the tumidity being surmounted by the granule, or granules.

The actinal intermediate plates are arranged in chevrons and decrease in size toward the margin. They are polygonal, and covered with a coarser granulation than the dorsal plates—a granulation which increases somewhat in coarseness toward the center of each slightly convex plate, which is surmounted by 1 to 5 enlarged granules, usually of unequal size. Scattered here and there are bivalved pedicellariæ, 0.25 to 0.75 mm. in length.

The furrow spinelets are 4 to 5 in number, robust, short, truncate, slightly flattened, the adoral spinelet shorter than the others. On the actinal surface of the plate stands a longitudinal series of 2 or 3 shorter, thicker, granuliferous spinelets, with often 1 or 2 smaller granules standing in line at either end of the series. Occasionally a very small bivalved pedicellaria stands at the adoral end of the series out of line. Behind the actinal series the fine granulation of the general surface begins, decreasing in size toward outer end of plate. The furrow spinelets appear a trifle shorter and heavier than those figured by de Loriol. A few of the proximal adambulacral plates have 6 furrow spinelets.

This species has a wide range, being found in following localities: Red Sea, Moluccas, New Guinea [Müller and Troschel], Mauritius, Macassar (Celebes), Fiji Islands [de Loriol], Ceylon, Madagascar, "Eastern Archipelago" [Sladen]. Its capture in the Hawaiian Islands considerably extends its known range.

Family PENTACEROTIDÆ (Gray) Perrier, emend. 1884.

Pentacerotidæ Gray, Synopsis of the Genera and Species of the Class Hypostoma. <Ann. N. H., ser. 1, vol. VI, 1840, p. 275.
Perrier, Mém. sur les Etoiles de Mer Recueillies dans la Mer des Antilles et le Golfe du Mexique, 1884, pp. 165, 168.

Key to Hawaiian genera of Pentacerotidæ.

a. Marginal plates fairly distinct, defining the contour of body.

b. Disk high; rays carinated. Large immovable spines or tubercles on the dorsal surface. Marginal plates not conspicuous..... PENTACEROS

bb. Disk not so high; form nearly pentagonal; marginal plates conspicuous. Erect conical tubercles on both surfaces ..... NIDORELLIA

aa. Marginal plates hidden or inconspicuous; not visibly defining the contour of body. The abactinal plates are not superficially distinguishable in the adult. Form thick.

b. A pair of large marginal plates at the end of the ray. Form substellate to stellate. Test covered with globose or acorn-shaped tubercles. Papulæ evenly distributed, not in definite areas. ASTERODISCUS

bb. Form pentagonal, biscuit-like; no large plates at end of ray. Papulæ distributed in large, definite areas ..... CULCITA

Genus PENTACEROS Schulze.

Pentaceros Schulze, Betrachtung der versteinerten Seesterne u. ihrer Theile, Warshau u. Dresden, 1760, p. 50. Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 276.
Goniaster (pars) Agassiz, Mém. Soc. Sci. Nat. Neuchâtel, t. I, 1835, p. 191.
Oreaster Müller and Troschel, System der Asteriden, 1842, p. 44. Bell, Proc. Zool. Soc London, 1884, p. 57.

The specimens of *Pentaceros* from the Hawaiian Islands have given considerable trouble, as might naturally be expected. Relying chiefly upon Prof. F. Jeffrey Bell's useful and valuable revision of the genus, "The Species of Oreaster" (Proc. Zool. Soc. Lond., 1884, p. 57), I have separated the form as a distinct species, whose affinities appear to be with the *Pentaceros orientalis* section. Among the species of this group it most resembles *orientalis* and *troscheli*. On the other hand, there are certain points of similarity with *P. occidentalis*. One of the difficulties lies in the fact that some specimens have the adambulacral armature disposed in 3 longitudinal series (triplacanthid), while others have but 2 series (diplacanthid). Just this state of affairs exists in *P. occidentalis* (from Mazatlan, Mexico). Bell places *occidentalis* in the diplacanthid section, but implies that occasionally a third furrow series is present. But *hawaiiensis* differs from *occidentalis* in a most important respect—that is, in its growth stages. In *occidentalis*, as pointed out by Bell and as exemplified by specimens at hand, the young are more spiny than the adult, while in *hawaiiensis* exactly the reverse is the case. In this species, if any spines are present in the young they are inconspicuous, and are confined to the median-radial line. *Hawaiiensis*, then, is probably not derived from the American form, but from the Asiatic group. In the following diagnosis a description of the type is given, but under each category of characters the more important variations are indicated.

Pentaceros hawaiiensis, new species.

Pl. XXXII, figs. 1, 2, 3; pl. XXXIII, fig. 1; pl. XXXIV, fig. 3.

Rays 5. R = 125 mm.; r = 50 mm. R = 2.5 r. Dimensions measured on ventral side. (In 2 larger specimens the rays are relatively shorter, R equaling 160 mm. and r about 78. In still another specimen, the largest of all, R = 188 mm., and R = 2.35 r.)

Disk large, elevated, and regularly convex; about 55–58 mm. high, measured from actinal plane. This dimension varies considerably according to the inflation of disk, several specimens being much depressed. Rays well produced, rather broad at base. Actinal area plane on rays, sloping upward toward actinostome on disk.

The whole abactinal surface is marked off by trabeculæ into large triangular, or on the ray often rectangular papular areas. On disk they are fairly regular, but on ray are irregular. At each angle is a large conical tubercle, there being a definite medio-radial series extending to tip of ray, and on either side 2 parallel longitudinal series, the first extending about half the length of rays, and the second not so far as the first. In interradial angle formed by the outer series of adjacent rays are 3 to 6 tubercles. The pentagon marked off by the conspicuously enlarged primary radial tubercles (apical area) is also divided into triangles, often very regularly into 10, but again irregularly. There is a variable number of smaller tubercles in this area (7 in type). All tubercles decrease in size toward tip of ray and margin of disk. Granulation consists of variously sized polygonal granules crowded together, often increasing in size as they ascend the tubercles, the spinous tip of the latter being always free from granules and the line of demarcation well defined. Granulation is finer than in either *P. reticulatus* or *P. occidentalis*, the only species with which I have been able to make direct comparisons. Numerous small slit-like pedicellariæ, flush with the general surface, are thickly scattered over

the whole abactinal surface, being present frequently on the bases of the tubercles, but most numerous in the papular areas.

Superomarginal plates, 23 in number from median interradial line to extremity of ray, are rather indistinct and are wholly without spines or tubercles of any description. Besides the granulation, which is coarser than that of the abactinal surface, and which increases in size toward the actinal surface, each plate bears 1 or 2 long slit-like pedicellariæ, larger than those of the dorsal surface but otherwise similar. Superomarginals define border of ray.

Inferomarginals, 20 in number, are confined almost wholly to actinal surface. Four or 5 on each side of median interradial line bear a small thimble-shaped tubercle, on a slight tumidity, near outer edge of plate. (This is absent from the largest and from the 2 smallest specimens.) The granules are very irregular as to size; and on each plate there are 1 to 5 slit-like pedicellariæ scattered among them. These have jaws slightly raised above the general level, and are narrowly elliptical in shape, with truncate ends. In the interbrachial arc there are 5 or 6 roundish plates intercalated between the 2 series of marginals. (These are absent from the 2 young specimens, and much more numerous in the largest. They are present also in *P. occidentalis* but do not appear so early. In a giant specimen of *reticulatus* I find no trace of them.)

Armature of adambulacral plates is in 2 or 3 series. (1) Furrow series of 8, less often 7, flattened, round-tipped spines, the central ones much longer than the laterals and their tips broader than base. Lateral-most spines scarcely equal one-half the length of longest spines; often mere elongated granules. This furrow series forms a regular comb, with a much rounded, often angular margin. Spines are united for some distance above their bases by a delicate web. A large forceps-like pedicellaria stands at adoral end of each series, slightly actinad. Furrow series is situated much higher (abactinad) on the side of furrow than the second series, the tips of the former only reaching or extending slightly beyond the base of the latter. (2) Second series, situated more nearly on true edge of furrow, consists of 2 to 4 spines, often only 2, this latter number predominating on the outer part of ray. They are of unequal size, very irregular, but the central spine (or 2 spines if there are 4) is largest, with the tip usually broader than the base, and rounded or truncate. Lateral spines vary much, but are shorter than the median and are either oblong or leaf-like, with a straight edge to the adjacent median spine. Toward the end of ray the second series is reduced to pinched granules. (3) Third series when present consists of 2 or 3, often 4, enlarged pinched granules, with rounded tips, in an irregular longitudinal row at outer edge of plate. In one large specimen the third series is present on nearly every plate, and is well developed, but in the majority of specimens, including type, it is poorly developed, being represented by granules of rather small size. Tips of second and third series of spines crinkled.

Actinal plates covered with granules, large and small, with many bivalved pedicellariæ scattered among them. The granules increase in size toward ambulacral furrows, becoming subtubercular or subspinose in the largest specimens. These tubercles are always mobile, however.

Actinal surface of mouth plates covered by the heavy granular integument, which has to be removed before the plates themselves can be seen. These are large, and when the integument is removed, a large convexity or tumid area is seen near the aboral furrow corner, which is surmounted by 2 to 5 heavy spines, corresponding to the second series. Furrow spines 10 or 11, increasing greatly in size toward the inner mouth angle, where they are large and heavy, and many times larger than at outer end of the series, where they are similar to those of the adjacent adambulacrals. (The actinal spines already mentioned vary in number, but there are never less than 2 nor more than 5.) Actinal surface (of integument) coarsely granular, with often very many pedicellariæ.

Madreporic body oval, either narrow or broad, situated outside the apical pentagonal area at a distance equal to one-half the distance from center to interradial edge of apical area. Anus eccentric, prominent.

Color in life: Upper surface maroon, orange on the tubercles. Actinal surface light Naples yellow in the center, shading into maroon toward the periphery.

Variations: The principal variations have already been noticed. One specimen, about the size of the type, has fewer and smaller spines on the dorsal surface, the median radial line extending only about one-half the length of ray. A larger specimen has the tubercles more acorn-shaped, and covered with granules except a bare blunt point at the tip. The connecting trabeculæ are likewise more prominent. The rays are longer and slenderer than in the type, but this character has no stability in this species.

Young: The smallest specimen examined (R=65 mm.; r=28 mm.; measured on actinal side) is destitute of all dorsal spines or tubercles, there being, along the median radial line, a series of bosses, or rounded elevations, where the tubercles later appear. No tubercles are present on the inferomarginals. Slit-like pedicellariæ are numerous on the dorsal surface, but the larger bivalved kind are not so numerous as in the adult on the ventral area. Third series of adambulacral granules is developed on most plates, the second series consisting of 2 or 3 stout elongated granules. In a specimen in which R equals 70 mm. a few conical tubercles have begun to appear along the median radial line, and 2 in the apical area. In this specimen the third adambulacral series is fairly well developed on all plates. In young specimens the papular areas are relatively smaller than in the adult, and the trabeculæ broader. The former are irregular, oval, or oblong, not triangular. In these two specimens the marginal plates are quite regular and there is no intermediate series intercalated between them in the interbrachial arc, as in the adult. All the granulation is more regular. In the largest of these immature specimens the actinal intermediate plates, roundish in shape, can quite clearly be seen, arranged in regular chevrons.

Localities: Type (no. 21171, U. S. National Museum) from station 3850, south coast of Molokai Island, 43–66 fathoms, coarse sand and broken shells, coral; bottom temperature 71.7°. Taken also at the following stations, in all, 14 specimens examined:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3849	South coast of Molokai Island	73–43	Coarse sand, broken shells, coral.
3872	Auau Channel, between Maui and Lanai islands	43–32	Yellow sand, pebbles, coral.
4072	North coast of Maui Island	56–59	Coarse coral sand, foraminifera.
4075	do	49–57	Fine gray sand, foraminifera.

Genus NIDORELLIA Gray.

Nidorellia Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 277. Type, *Nidorellia armata* Gray.

Nidorellia armata (Gray).

Pentaceros (*Nidorellia*) *armatus* Gray, Ann. N. H., VI, 1840, p. 277; Synopsis Starfishes, p. 7, pl. XIV, fig. 1-3, 1866.
Nidorellia armata Verrill, Trans. Conn. Acad., vol. I (2d pt.), 1867, p. 251. Perrier, Révision des Stellérides, p. 251, 1875.
Oreaster armatus Bell, Proc. Zool. Soc. Lond., 1884, p. 81.

Prof. F. Jeffrey Bell in his paper "The Species of Oreaster" records *Nidorellia* from the Sandwich Islands. This form was not found by the *Albatross* Expedition.

Genus ASTERODISCUS Gray.

Asterodiscus Gray, Proc. Zool. Soc. London, part XV, 1847, p. 75. Type, *Asterodiscus elegans* Gray. See also Ann. N. H., 1847, p. 196; Synop. Spec. Starfish, British Mus., 1866, p. 5, pl. XII, figs. 1 and 2.

This peculiar genus may be readily distinguished from others of the Hawaiian region by its thick body, short rays, and tough test covered all over with tubercles, large and small, among which are many granules, ranging down to the most minute. The general form is depressed, while the rays are blunt, and bear at the tip 2 large convex, oval ossicles, between which is set the tubercular terminal plate. *Culcita*, the only other genus closely resembling this, entirely lacks the 2 enlarged plates.

The specimen at hand differs in several important respects from both Gray's figures and description of *Asterodiscus elegans* (Synopsis, p. 5, pl. 12, figs. 1 and 2). The body is not so pentagonal, for there are distinct rays present which are more marked in this adult individual than in the young specimen of *elegans* which Gray has figured (op. cit., fig. 2). There is no distinct medioradial line of tubercles larger than the rest. Gray's description states that the tubercles of *elegans* are "flat-topped", and again, "truncate", which in nowise applies to our specimen, for here the tubercles are roundish-subconicle, or acorn-shaped with a blunt point. Gray further says: The young specimens have indistinct marginal ossicula". One specimen, which is clearly adult, has both series of marginal plates quite distinct, the inferomarginals the more numerous; while in 2 young specimens (R=10 mm.) the marginal plates are as distinct as in any goniasterid, the animal resembling, at first glance, a starfish

of the *Pentagonaster pulchellus* type. There is, however, a single series of plates between the upper and lower marginal series.

On the whole our specimen appears to belong to a different species. *Asterodiscus elegans* comes from off Samboagan, Philippine group (Challenger), and from northeast coast of China (Perrier, Rév. Stell.).

Asterodiscus tuberculosus, new species.

Pl. XXVI, figs. 2, 2a; pl. XXVIII, fig. 3; pl. XXXII, figs. 3, 4; pl. XXXIII, fig. 2; pl. XXXIV, 1, 2.

Rays 5. R=69 mm.; r=about 40 mm. (r being variable). R=1.7r. Breadth of ray at base, about 45 mm. Rays short and broad, tapering to a blunt extremity; rather unequal as to width and length. Disk large, somewhat inflated. Interbrachial arcs widely rounded. Side of body fairly high, but well rounded.

Abactinal surface is covered with numerous large tubercles shaped something like a miniature acorn, or like a pointed egg standing on its blunt end. A fairly regular median radial line of them is present with an adradial series, but beyond these the tubercles are too irregular to form definite series. Each tubercle stands on a slight prominence of the test, and its base is surrounded by a circle of small, regular, bead-like granules, very ornate in appearance. These tubercles are largest near the extremity of rays and in center of disk. Scattered thickly among the tubercles, forming indefinite rows on the arms, are large spherical granules, from one-fourth to one-half the size of the smaller tubercles, their bases also encircled by minute granules. In addition to these larger granules, there are many others, grading down to very minute ones which thickly cover the whole test.

Marginal plates are not conspicuous, in fact can be seen only as separated ossicles. Corresponding to the superomarginal plates are 3 ossicles (from interradial line), omitting the large plate at the extremity of the ray. The innermost ossicle is near the interradial line not far from its companion of the adjacent ray. The second plate is about 5 mm. from the first, and the third 8 mm. from the second. The third is 15 to 18 mm. from the large plate at tip. Each plate is convex, circular, about 3 mm. in diameter, and encircled by a row of regular, subquadrate, bead-like granules. Each plate bears 1 or 2 large spherical granules or small tubercles on its edge. The large plate at the end of the ray (7 mm. in length) is very convex, oval, and is surrounded by a regular series of small, bead-like granules.

Inferomarginal plates, 9 or 10 to each ray, are smaller than the superomarginals, and are separated from them by about 5 mm. of test, thickly covered with tubercles and granules. On the upper side of each ossicle is a large subconical tubercle, the series increasing in length toward tip of ray. Clustered about the base of each tubercle are numerous close-set granules of various shapes, which continue as a single row around the inferomarginal ossicle, and, at tip of ray, completely cover the exposed surface of distal 2 or 3 plates. The last are more tumid than the others, and are wedged in between the big terminal superomarginal and adambulacral plates. In addition, 2 or 3 pincer-shaped pedicellariæ, with curved jaws, occur on the ventral side of the inferomarginal ossicles.

Actinal area is very knobby, with many spherical tubercles, much smaller than those of dorsal surface and more regularly arranged. Each plate bears 1 or 2 tubercles, surrounded by large, irregular granules, often subprismatic, 4-sided, or at least with a flattened side next to tubercle. An indefinite series of small granules often occurs outside of these, and near the furrow replaces them to some extent. Many actinal plates of ray have delicate pincer-shaped pedicellariæ, with elongate jaws often curiously curved. They are smaller than those found on inferomarginals, and are present in interradial region.

Adambulacral armature similar to that of *elegans*. Composed as follows: (1) A nearly straight furrow series of 6 (often 5) spines, subequal except the adoral, which is smaller and hidden. Spines fit closely together, have blunt tips, and are flattened somewhat. They are united by a thin web for about half their length. (2) On first 6 to 9 plates 2 series of heavy blunt tubercular spines, the inner slightly longer than the furrow series. The inner series has 2 spines, the adoral the smaller. External to these stands the third spine, shorter than the inner, composing the outer series. On actinal surface of the other plates there are but 2 spines, standing in a transverse series; while near tip of ray only the inner spine persists, and is slender and pointed. Actinal spines are surrounded by a number of unequal irregular granules, 1 or 2 on the outer adoral corner being larger than others. No pedicellariæ such as Sladen found in the *Challenger* specimen of *elegans* (Challenger Asteroidea, p. 353) are present on any of the adambulacral plates.

Mouth plates narrow, small, inconspicuous, with a furrow series of 11 spines like those of the adambulacrals except the inner 2, which are heavier, blunter, and form with the corresponding spines of the companion plate 4 teeth at each mouth angle. A row of 3 or 4 robust blunt spines are present on the actinal surface of the plate, parallel with the furrow series. A series of small pinched granules extends around the margin of each plate, except, of course, that part adjacent to the furrow.

Madreporic body small, convex, raised above general surface of integument. It is situated about one-third distance from center to margin, and lies off the exact interradial line. Striations convoluted. Anal opening eccentric, surrounded by large globular granules.

Color in alcohol, ashy.

Young: There appears to be no description of a young *Asterodiscus* beyond the few words of Gray. The young of the present species seems considerably different from that of *elegans*. Rays are well marked, regular, short, tapering from a broad base. Disk, large; interbrachial arcs widely angular. R=10 mm.; r=6.5 mm. R=1.54 r. Marginal plates well developed, conspicuous, separated by an intercalated series of very much smaller ossicles, each bearing a globular granule nearly as large as the exposed surface of the plate. Superomarginals are 4 in number from median interradial line to extremity of ray, the last plate being very large and swollen as in the adult, and separated from that adjacent by a transverse series of 2 abactinal plates. Each plate with the exception of the last is slightly convex, is surrounded by a series of bead-like granules, and bears 2 or 3 granules on its surface, one being usually larger than the rest. The large plate has a smooth surface. It will be seen that superomarginals do not increase in number beyond this stage, the ray growing by the interpolation of abactinal plates between the superomarginals, principally between the third and fourth. Inferomarginals 8 from median interradial line, subcircular, surrounded by many small elongated granules in a definite series, each plate resembling a composite flower with short peripheral florets. A tubercle stands at the upper edge of each plate, and increases in size toward the end of ray. In the adult, which has but 10 inferomarginals, the growth of intermediate plates is principally between the third to seventh plates. The single intermediate series of plates between the dorsal and ventral marginals is readily distinguishable in the adult, and is situated rather nearer the inferomarginals, with which the intermediate plates alternate.

Abactinal plates are large, circular, arranged in very regular series parallel with the median radial row; or, in other words, they form chevrons, the axis of which is interradial. Plates decrease in size toward the periphery and each is surrounded by a circle of small bead-like granules and bears a large rounded, depressed tubercle which occupies the whole surface of the plate. Primary apical series very large, especially the "basals", which bear a much smaller convex granule in the center, instead of the enlarged tubercle. A single series of plates between adjacent basals. Within the apical area bounded by the basals are 5 regular plates (radial in position) and a definite "central". Primary "radials" are situated just outside of the basals; larger than others of the radial series. Papulæ are distributed all over the abactinal surface. Madreporic body just outside of a "basal" plate.

Actinal intermediate plates are arranged in regular chevrons, and are not distinct superficially. Each is armed with a globular or obovoid tubercle surrounded by a semicircle of 2 to 5 pinched granules. Adambulacral plates have 3 spinelets in furrow series, and one actinal spine instead of 2 or 3. Several granules stand on the outer edge of the plate, one usually larger than the others. No pedicellariæ are present.

The color of the young in life is cadmium orange; in alcohol bleached ashy or whitish.

Localities: Type (no. 21172, U. S. National Museum) from station 3940, vicinity of Laysan Island, 59–70 fathoms, white sand and broken shells; bottom temperature, 70°. Two young specimens from 4128, southeast of Kauai Island, probably about 68 fathoms, coarse brown coral sand, foraminifera.

Genus CULCITA Agassiz.

Culcita Agassiz, Mém. Soc. Sci. Nat Neuchâtel, t. I, 1835, p. 192.

Culcita arenosa Perrier.

Culcita arenosa Perrier, Recherches sur les Pedicellaires, 1869, p. 66; Révision des Stellérides, 1875, p. 264. Sladen, Challenger Asteroidea, 1888, p. 352.

Culcita novæguineæ var. *arenosa*, Doederlein, Bericht ü. d. v. Herrn Prof. Semon bei Amboina ges. Asteroidea, in Semon, Zool. Forsch. in Australien u. d. Malay. Archipel. (Jenaische Denkschrift, bd. VIII, 1896, p. 315, taf. XIX, fig. 5 and 6.

This species was not taken by the *Albatross* expedition. The specimen which Perrier described was collected by the expedition of Eydoux and Souleyet in the *Bonite* in 1837, "des îles Sandwich."

Family LINCKIIDÆ Perrier, 1875, emend.

Linckiidæ Perrier, Revision de la Collection de Stellérides du Museum d'Histoire Naturelle de Paris, 1875, p. 117.

Key to Hawaiian genera of Linckiidæ.

a. Plates in regular longitudinal series, between which are regular series of papular areas. Adambulacral armature in 2 (rarely 3) unequal series, the outer heavier than the inner and more distinctly spaced.
  b. All the plates granular ..... OPHIDIASTER
  bb. Whole test covered with a thick membraneous investment devoid of granules ..... LEIASTER
aa. Abactinal plates not forming regular longitudinal series.
  b. Abactinal plates comparatively small. No papulæ on actinal surface. Papulæ in areas distributed among the abactinal plates. Adambulacral armature granuliform superficially, in 2 or 3 series ..... LINCKIA
  bb. Abactinal plates comparatively large. Papulæ in areas; sometimes present on the actinal surface. Adambulacral armature papilliform or spiniform superficially, usually in 3 series ... NARDOA

Genus OPHIDIASTER Agassiz.

Ophidiaster Agassiz, Prod. Monogr. d. Radiares. <Mém. Soc. Sci. Nat. Neuchâtel, t. 1, 1835, p. 191. Type, *Asterias ophidiana* Lamarck.

Key to Hawaiian species of Ophidiaster.

a. Papular areas in 8 longitudinal series. Papulæ on actinal surface. One or 3 series of actinal intermediate plates.
  b. A single series of actinal intermediate plates.
    c. Well developed pedicellariæ present. Madreporic bodies 2, small ..... *lorioli*[a]
    cc. No pedicellariæ. A single moderately large madreporic body ..... *squameus*
  bb. Three series of actinal intermediate plates proximally, 2 distally. Actinal series of papular areas not reaching base of ray ..... *rhabdotus*
aa. Papular areas in 6 longitudinal series. No papulæ on actinal surface. Two or 3 series of actinal intermediate plates.
  b. Abactinal and marginal plates neither nodose nor with conspicuous central naked area. Adambulacral spinelets in 2 series.
    c. Rays less than 4 times as long as diameter at base. Papular pores 9–15. Disk relatively large ..... *scleroderma*
    cc. Rays more than 5 times as long as diameter at base. Papular pores 1 or 2. Disk small, rays slender ..... *tenellus*
  bb. Abactinal and marginal plates conspicuously tumid or nodose with naked central area. Adambulacral spinelets in 3 series ..... *triseriatus*

Ophidiaster lorioli, new species.

Pl. XXXI, figs. 4, 4a–d; pl. XXXIX, fig. 3.

Rays 5. R=31 mm.; r=4.5 mm. R=7r. Breadth of ray at base, 4.75 mm.; at middle of ray 4–5 mm. Height of ray at base, 4.5 mm.

Rays long, nearly cylindrical, or, in one case, distinctly depressed, tapering gradually on the outer part to a blunt extremity. Abactinal surface of disk slightly convex, a very slight constriction being present on dorsal surface between ray and disk. Papular areas regular, in 8 longitudinal series, 3 pores to the area except in the actinal series and on the outer third of ray, where there are usually 2. On disk there are but 7 or 8 areas, with 2 pores to each. The single series of actinal intermediate plates is not externally visible. The plates are much smaller than the inferomarginals, 3 or 4 of the former corresponding to 2 of the latter. The other plates of ray, namely, the radial, adradial, supero- and inferomarginals, form 7 longitudinal series, the plates being cordate, the narrower or adoral

[a] J. E. Ives has recorded (Proc. Philad. Acad. Sci., 1889, p. 172) 5 specimens of *Ophidiaster pusillus* Müller and Troschel from Oahu. It is barely possible that these specimens are *O. lorioli*. *Ophidiaster pusillus* has pedicellariæ something like those of *lorioli*, but there are only 6 longitudinal series of papular areas. The species has been taken at Flores, Amboina, Philippine Islands, New Caledonia.

end overlapping the broader or aboral end of the preceding plate. The marginal plates are a trifle larger than the abactinal, and all are moderately convex, the transverse as well as the longitudinal furrows between the plates being well marked. The skin which covers the plates bears relatively large flat granules which are very much larger in the center of the plate than about the borders and smallest immediately surrounding the papulæ. The small granules are very irregular in shape, and not at all uniform in size. The larger are more roundish and very slightly imbricating. In one specimen they imbricate more noticeably and appear remarkably scale-like, the outer or free edges being subangular or obtusely pointed in many cases. Extending along the papular furrow between the superomarginal and adradial series of plates on either side of the ray is a row of peculiar and conspicuous 2-jawed pedicellariæ, about 10 to 12 in number, sometimes less. There is but 1 pedicellaria to an area and it is large enough to be readily seen without magnification. Each consists of a double, broadly spatulate, specialized depression with a denticulate margin, into which fit, when open, the broad fan-shaped jaws, which bear 5 teeth or serrations at the edge, fitting nicely into 5 notches in the edge of the specialized depression. The figure will give the exact appearance of these. There are also 3 to 5 of the pedicellariæ scattered on disk (abactinal) and usually 1 in each actinal interradial area, although this is occasionally absent in 1 or 2 interradii. One or 2 pedicellariæ may be found at base of ray adjacent to that in the interradius.

Adambulacral armature consists of 2 series of spinelets. Furrow series consists of small spinelets, the tips of which extend but a slight distance above the general granulation, and these tips are alternately larger and smaller although the difference is slight. When a portion of one side of the very narrow furrow is removed the spinelets are seen to be about twice as high as broad, with a rounded-truncate tip. The adoral is a shade narrower than the aboral member, but it is the latter that appears smaller (or more compressed) when viewed from the actinal surface. The difference in size is not constant, however, and is of little importance. Between 2 plates there is frequently a small granule fastened to the adoral edge of the adoral spinelet. On the actinal surface, spaced from the furrow spinelets a distance something less than their length, is a longitudinal series of larger ovoid tubercles which are not equidistantly placed, 3 to 6 of the furrow spinelets corresponding to 2 of the actinal. Small, rather scale-like granules are packed in the space between the 2 series of spinelets. The outer spinelets are bent away from the furrow.

Madreporic bodies 2, small, situated rather nearer the margin than midway to center of disk. They are situated in neighboring interradii, but one is somewhat off the median interradial line. The bodies are flush with the general surface and the striations are few and coarse, either a smaller sinuous line, or V-, U-, and Y-shaped. Anal apertures apparently 2, surrounded by larger granules.

Color in alcohol a bleached yellowish.

Locality, station 3834, south coast of Molokai Island, on reefs; shore (4 specimens). Type no. 21173, U. S. National Museum.

This species is closely related to *O. robillardi*[a] P. de Loriol, and more remotely to *O. germani*[b] Perrier and *O. cribrarius*[c] Lütken.

From *robillardi* it differs in having a coarser granulation, often scale-like, on the median portion of the plates, while that about the edges is finer; the pedicellariæ are broader, with more denticulations, and the outer surface of each jaw is grooved near the free edge. The pedicellariæ are single to a plate as in *robillardi*, but are situated in a papular area rather than on the plate. There is a slight inequality in the furrow spinelets, and the accessory granule, instead of being between the 2 spinelets of a plate as in *robillardi* is always found between 2 plates. The following synopsis will serve to indicate the chief differences between the 4 related species.

a. Papular pores 3 (2–4); plates more prominent.

b. Arms usually flattened, granulation uniform, pedicellariæ narrower, 3 or 4 denticulations on free edge; outer surfaces of jaw not grooved; pedicellariæ on plates; furrow spinelets equal; accessory granules between the 2 spinelets of a plate ..... *robillardi*

bb. Arms usually cylindrical, granulation conspicuously larger in center of plate; jaws of pedicellariæ nearly or quite twice as broad as high; 5 denticulations on free edge; pedicellariæ on edge of papular areas, one to an area; furrow spinelets rather unequal; accessory granules between the adjacent spinelets of 2 adjacent plates ..... *lorioli*

[a] Catalogue Raisonné des Échinodermes recueilles par M. V. de Robillard à l'Ile Maurice. < Mém. Soc. Physique et d'Hist. Nat. Genève, t. XXIX, no. 4, 1885, p. 24, pl. XV, figs. 1–5.

[b] Révision des Stellérides, 1875, p. 130.

[c] Vidensk. Meddel., 1871, p. 277.

aa. Papular pores 10–12; plates less prominent.

b. Furrow spinelets equal ..... *germani*

bb. Furrow spinelets unequal ..... *cribrarius*

Ophidiaster robillardi is found at Mauritius, an interesting fact when considered in connection with *Valvaster striatus*, a species from Mauritius also occurring in the Hawaiian Islands. *Germani* is found at New Caledonia and *O. cribrarius* at the Tonga Islands and Samoa.

Named in honor of Prof. P. de Loriol, author of a classical series of papers on living and fossil echinoderms.

Ophidiaster squameus, new species.

Pl. XXXI, fig. 6, 6a-b; pl. XXXVII, fig. 4.

Rays 5. R=19 mm.; r=3 mm. R=6.3r. Breadth of ray at base, 3.25–3.75 mm.; at middle of ray 3.75 mm.

Rays unequal, cylindrical, scarcely tapering at all until the outer third is reached, and then only slightly. Tip blunt; terminal plate large, conspicuous, smooth, several small tubercles being present at the outer end. No pedicellariæ whatever. Papular pores in 8 longitudinal series, 2 or 3 conspicuous pores to each area, but only one at the tip of ray and on disk. The plates are markedly convex, and the longitudinal series are very regular and separated by very evident papular furrows which extend the lengh of the ray. In a transverse direction the plates are marked off by a trifle shallower furrows, at the bottom of each of which is a narrow groove bordered by fairly regular globular granules. The plates are cordate and arranged in a radial series on either side of which is an adradial, supero- and inferomarginal, and an actinal intermediate series bordering the adambulacrals. There are 2 actinal intermediate plates to each inferomarginal. The plates are covered with relatively very coarse granules for the genus, and these are subcircular to oval, convex, and much larger in the convex central portion of the plate than at its edges. Along the aboral and adoral edges they frequently form a border to a narrow groove as already indicated. From 2 to 6 or 7 granules in the center, especially on the marginal plates, are conspicuously larger than the others and imbricate slightly, but slight spaces are frequently seen where the circular granules touch and do not overlap. On the inferomarginal plates 1 or 2 of the granules, especially on the outer part of the ray, are subtubercular.

Furrow spinelets are not so large, 2 to the plate, equal, slightly over twice as long as wide, round-tipped and flattened. As they are placed on the plate the adoral appears outwardly a trifle longer than the other. Each spinelet has a small elliptical granule fastened to the furrow side and lying over the crack between adjacent spinelets. The lower end of this granule reaches about to the middle of the spinelet, and its upper end falls considerably short of the tip. Spaced from the furrow series, on the actinal surface, is a longitudinal row of much stouter, broadly ovoid or subconical granules or tubercles, of which 2 correspond to 3 furrow spinelets. The space between the 2 series is filled in with small, compressed subsquamiform granules, about 1 series of which pass between the actinal spinelets. The actinal intermediate plates have 1 or 2 central granules larger than the rest, but the general granulation of these plates is intermediate between that of the adambulacrals and the inferomarginals.

Madreporic body fairly large, regularly circular, situated about midway between center and edge. About the edge of the plate, which is perfectly flat, is a smooth unstriated border. Striations coarse, irregular. On the adcentral side are 5 or 6 granules larger than the others. Anal opening guarded by 4 triangular granules much larger than any others nearby.

Color in life, vermilion; in alcohol, pinkish with pale yellowish spots here and there.

Localities: Station 4100, Pailolo Channel, between Maui and Molokai islands, 130–151 fathoms, coral sand, shells, foraminifera; bottom temperature 61°; 1 specimen. 4023, Vicinity of Kauai Island 18–41 fathoms, gray sand foraminifera, coral, rocks; 1 specimen, very young. Type no. 21174, U. S. National Museum.

The nearest related species to this appears to be *Ophidiaster purpureus* Perrier[a] from which *squameus* differs in having a still coarser granulation, in being devoid of pedicellariæ, and in having thicker actinal adambulacral spinelets, which are also situated closer together, so that 1, or at most 2, series of small granules separate them. The terminal plate is apparently larger than in purpureus, and the arms relatively shorter. It differs in the same respects, practically, from *O. pustulatus* (v.

[a] Recherches sur les Pedicellaires, etc., 1869, p. 61. Révision des Stellérides, 1875, p. 127.

Martens)[a] with which Doederlein[b] has recently united *purpureus*, the 2 having been taken at Mauritius; and the former is recorded also from Amboina and Flores, and the latter from the Seychelles. The name refers to the large granules which have the appearance of scales.

Ophidiaster triseriatus, new species.

Pl. xxx, fig. 3; pl. xxxi, figs. 7, 7a.

Rays 5. R=18.5 mm.; r=4 mm. R=4.6 r. Breadth of ray at base, 4.75—5 mm.; ray about 5.2 times as long, measured on side, as width at base.

Disk rather large for genus, rays stout; slightly tapering to a blunt extremity which is capped by a tumid terminal plate bearing 3 or 4 low tubercular knobs. Rays well arched above, slightly flattened actinally, yet rounded. Interbrachial arcs acute, fairly wide. Abactinal and marginal plates very tumid, forming 7 fairly regular series separated by conspicuous furrows containing papular areas. Medioradial and superomarginal plates largest and most convex, some of them appearing almost hemispherical. Proximal plate of each radial series largest of all, forming a regular pentagon on disk. Between inferomarginals (which are smaller than superomarginals) and the adambulacrals are 2 rows of actinal intermediate plates proximally, becoming 1 on distal two-thirds of ray. The granulation is of medium coarseness. Granules are roundish or roundish polygonal, and are a trifle larger in the center of those plates which are wholly covered than in the papular furrows. Transverse, fairly regular, fine cracks between larger plates are bordered by slightly enlarged granules. The cracks are usually conspicuous between marginal plates, and on proximal portion of ray. Most of the plates of median radial series (including the large primary radial) and of superomarginal have the exposed rounded surface either partially or wholly free from granules. A number of the adradial and inferomarginal plates, which are not so tumid as the others, have a naked central area. This exposed portion of the plate is quite smooth and on the distal half of the ray is rather more hemispherical and prominent than elsewhere (excepting the 5 primary radials). A number of adradial and superomarginal plates possess a 2-jawed spatulate narrow pedicellaria with curved spectacle-shaped (pince-nez) fossæ very similar to those of *O. sclerodermus*. The fossæ are surrounded by a small naked area. Papular areas in 6 longitudinal rows, 3 to 5 small pores to each area. On distal portion of ray, owing to the crowding of the adradial series of plates by enlarged radial and superomarginal plates, the adradial series of papulæ is absent and the superomarginal is reduced to a single pore to an area, or, at very tip, where the superomarginal and radial plates touch, both series of papulæ may be wanting. Inside apical area of disk there is but 1 pore to a papular area.

Adambulacral furrow spinelets 2 to each plate, oblong, equal, round-tipped to truncate. Separated from these by a distance equal to one-half to three-fourths their length is a flat obovate squamiform spinelet or tubercle, on actinal surface of plate. These form a very regular series and are directed away from furrow. Touching the base of each of these spines on the aboral side is a round-tipped slightly compressed granule, larger than the other granules of actinal surface, the series of which is quite regular and is intermediate between furrow and actinal spines. Granulation of actinal surface is very slightly coarser than that of abactinal, but surrounding the adambulacral spines is a trifle finer than on actinal intermediate plates. On one ray there is a single pedicellaria on 1 of inner plates of latter series.

Madreporic body subcircular, situated between 2 large convex radial plates. Striations irregular, branching, centrifugal. Six or 7 enlarged granules surround subcentral anal aperture.

Variations: Another much smaller specimen from the same station (R=7 mm) agrees very well with the type except that the plates, especially the primary radials, are not so prominent, and all of the latter but one are covered with granules. The intermediate series of adambulacral granules is much more prominent than in the type, nearly or quite equaling the furrow granules or spinelets in size. As would be expected, papulæ are fewer, there being but 1 to each area. Pedicellariæ are as yet undeveloped. Many of the plates of ray, as in the type, are naked, but this portion is not quite so prominent, although already very convex.

Locality: Station 4128, vicinity of Kauai Island, 68–90 fathoms, coarse brown coral sand, foraminifera, 2 specimens. Type no. 21176, U. S. National Museum.

[a] Ostasiat. Echinod.<Arch. f. Naturg., Bd. 32, 1866, p. 62.

[b] Bericht. ü. d. v. Herrn Prof. Semon bei Amboina ges. Asteroidea, in Semon, Zool. Forsch. in Australien u. d. Malay Archipel.<Jenaische Denkschrift, Bd. VIII. 1896, p. 317.

This species is characterized especially by the very prominent abactinal plates, many of which are naked centrally and form well-rounded bosses along the rays; also by the form of the pedicellariæ and the character of the adambulacral armature, which is disposed in 3 series, the median being smaller than either the outer or inner. In the latter feature this species bears a certain resemblance to *O. tuberifer* Sladen, but is otherwise quite different, as may be seen by comparing figures. Although the type is still probably young, the characters appear to be sufficiently well marked to merit description. The name refers to the 3 series of adambulacral granules.

Ophidiaster sclerodermus, new species.

Pl. xxx, figs. 4, 4a; pl. xxxi, figs. 2, 2a.

Rays 5. R=63 mm.; r= 13 mm. R=4.8 r. Breadth of ray at base, 15–16 mm.; at middle of ray, 10 mm. Height of ray at base, 10 mm.

Disk decidedly large for genus; rays only moderately long, tapering from a fairly broad base (for the genus) very gradually to a blunt extremity, which is tipped by a prominent terminal plate. The rays are decidedly broader at base than elsewhere, and measured along its side each ray is 3½ times longer than broad. The interbrachial angles, about 75° to 85°, are not sharp. Abactinal surface convex, but only slightly so in middle of disk; actinal surface nearly plane, the inferomarginal plates forming a well-rounded border to the area. No papulæ on ventral surface.

The plates are prominent on abactinal and lateral surfaces, the longitudinal series being separated by prominent but shallow papular furrows. The transverse divisions between the plates are not nearly so evident, the plates themselves being entirely hidden by the finely granular, thick skin. One can distinguish readily a radial series, and on either side an adradial, a supero, and inferomarginal, the superomarginal defining border of ray when viewed from above. Between the inferomarginal and adambulacral series there are, at base of ray, 3 series of smaller intermediate plates, which are reduced to 2 beyond the proximal third of ray and to 1 on distal third. There are no papular pores between these plates. Whole body is covered with a remarkably tough, thick skin, which is closely covered with a uniform, very fine granulation. Although this specimen is many times larger than the type of *O. lorioli*, the granules are actually much smaller. On the outer third of the ray the plates are frequently irregular in disposition, and on 1 ray of the type the plates are all irregular, as if from some sort of injury. Papular areas form 6 longitudinal series; 9 to 14 pores to an area on proximal two-thirds of ray, but on the distal portion fewer; and frequently there many papular areas are absent. The pores are many times larger than the granules, which are here a trifle larger than on the plates. The pores form irregular stenciled lines, resembling letters or simple hieroglyphics. There are few papular areas in the central portion of disk. Small 2-jawed entrenched pedicellariæ are abundant. Each consists of 2 narrow, spatulate, smooth blades, set in a little pit and lying each in a specialized depression with a smooth, rounded border. The whole apparatus is 1.5 mm. long, and the jaws are usually curved, making it crescent-shaped. On the proximal part of ray a series of 3 to 12 of these pedicellariæ are present just external to the outer adambulacral spinelets, and they are widely scattered on the marginal and abactinal plates, 1 to a plate, but are most numerous in the proximal regions. Occasionally a pedicellaria has 3 jaws.

Furrow spinelets, 2 to a plate, are much flattened, rounded-truncate, subequal, or the adoral is a shade narrower at the base. They are about twice as long as broad and the adoral is usually a little broader at the tip than at the base. The furrow face is flat or a trifle concave near base. External to these spinelets, at a distance equal to one-third or one-half their length, is a regular series of equidistant, somewhat flattened, broadly ovoid tubercles, the exposed portion of which is about two thirds the length of the furrow spinelets, of which about 3 correspond to 2 tubercles. Packed closely about the tubercles and filling the space between them and the furrow are many roundish or compressed granules, a trifle larger than the rest of actinal granules. Here and there one can distinguish lines, bordered by slightly larger bead-like granules, running out from the furrow toward the marginal plates, and similar fainter lines can be distinguished, with the aid of a glass, between many of the plates themselves. The mouth spinelets are like the adambulacral but a trifle larger.

Madreporic body inconspicuous, but fairly large, cordiform or shield-shaped. Striations fine, interrupted, branching, centrifugal. The plate is perfectly flat and is situated nearer margin than center. Anal aperture is surrounded by a number of considerably enlarged granules.

Color in life: Above, orange yellow with maroon blotches; below, light yellow. In alcohol, bleached grayish yellow or ashy.

Locality: Station 4077, north coast of Maui Island; 99–106 fathoms, fine coral sand, foraminifera, bottom temperature 70°; 2 specimens. Type no. 21175, U. S. National Museum.

Ophidiaster tenellus, new species.

Pl. xxxi, figs. 5, 5a.

Rays 5. R=52 mm.; r=7.5 mm. R=7 r. Breadth of ray at base, 9 mm.; at middle of ray, 5 to 5.5 mm. Height of ray at base, 6 mm. Rays 5½ times as long as diameter at base measured along side.

In general features resembling the preceding species, but with much longer and slenderer rays; a relatively coarser but uniform granulation, a very much thinner skin, 1 or 2 pores to each papular area, and fewer pedicellariæ. The third or outer series of actinal intermediate plates is rudimentary.

The plates are a trifle less prominent than in preceding species, but there is a perfectly evident though extremely fine transverse crack traversing the granulation between the plates. The longitudinal papular furrows are well marked but shallow. There are 6 rows of papulæ, which are solitary or in twos (rarely 3). No papulæ on actinal surface. The granulation is fine and uniform but increases in coarseness on the actinal surface near the furrow, where the granules occasionally appear scale-like. As in the last species the plates on one ray are somewhat irregular in disposition near the extremity. Two- or occasionally 3-jawed pedicellariæ form a series on the proximal third of ray at either side of the furrow just external to the outer adambulacral spinelets, and a similar series is present on the outer row of actinal intermediate plates and fewer on the 2 series of marginals. On abactinal surface pedicellariæ are rare.

The furrow spinelets are about equal in size, 2 to a plate, and slightly spaced. They are much flattened, truncate, a trifle broader at the tip than base, and the inner or furrow face has a very shallow groove running from end to end. The spinelets project a considerable portion of their length beyond the general level of the actinal surface of the plates. The actinal adambulacral tubercles are flattened, ovoid or obovoid, granuliform, bent away from furrow, and form a series just external to the furrow spinelets, so that only 1 series of granules intervenes between the 2. There is 1 of these tubercles to every third or fourth furrow spinelet, and they are not nearly so long as the latter. The granules of the adambulacral plates are larger than those of the actinal intermediate plates, into which they grade imperceptibly.

Madreporic body circular, of moderate size, situated midway between center and interbrachial angle. Striations deep, irregular, branching, centrifugal.

Color in life: Buff above, deeper ochraceous in the papular areas; below, cream color. In alcohol, ashy.

Locality: Station 4100, Pailolo Channel, between Molokai and Maui Islands, 130–151 fathoms, coral sand, shells, foraminifera; bottom temperature 61°. 1 specimen, type no. 21177, U. S. National Museum.

Ophidiaster rhabdotus, new species.

Pl. xxx, fig. 2; pl. xxxi, fig. 8.

Rays 5. R=80 mm.; r=11 mm. R=7.3 r. Breadth of ray at base, 11 mm.; at middle of ray, 8.5 mm. Height of ray at base, 8 mm. Ray 5 to 6 times as long as diameter at base, measured along side. Interbrachial arcs not very acute. Rays appear conspicuously fluted.

In general form resembling the preceding species, but differing in having more regular and more convex abactinal and marginal plates, 8 instead of 6 rows of papular areas, and 4 pores (3 to 5) instead of 1 to the area; outer or third row of actinal intermediate plates reaching one-third length of ray, and granulation a trifle coarser.

Marginal and abactinal plates form 7 regular convex series separated by 6 equally regular furrows containing the papular areas. At tip of some of the rays this regularity is completely interrupted. There is also a slight transverse furrow between consecutive plates, but this is not nearly so conspicuous as the longitudinal sulcus. In the granulation between consecutive plates there is likewise a fine transverse crack, which is sometimes bordered by slightly larger granules. The marginal plates are slightly larger than the abactinal, and very regular except at end of ray. Between the inferomarginal

and adambulacral plates are 3 series of regular actinal intermediate plates, but beyond the twelfth inferomarginal or basal third of ray there are but 2 such. There are 8 rows of papular areas, the actinal row (between inferomarginal and outer actinal intermediate plates) ending within 10 to 15 mm. of the interbrachial arc. This series contains but 2 or 3 pores to the area, and is not sunken in a furrow, as the marginal and dorsal areas, which comprise 4 or 5 pores, usually 4. The plates are covered, as in the 2 preceding species, with a membrane closely beset with fine granules. This skin is thinner than in *sclerodermus* and the granules are relatively considerably larger, yet fine, being coarsest on the convexity of the plates and only one-fourth or one-third as coarse in the bottom of the papular furrows. The granulation becomes very gradually coarser on actinal intermediate plates, yet is relatively (to the size of the spinelets) finer immediately adjacent to furrow than in *tenellus*, since the granules again grow smaller as they surround the actinal furrow spinelets. Here and there on the abactinal plates, and on the papular areas of intramarginal series, as well as on the actinal intermediate plates of proximal portion of ray, are small "spectacle-shaped" pedicellariæ, occurring singly, similar to but smaller than those of *sclerodermus*. The figures will sufficiently show the form. On proximal portion of the ray a short series of them occurs just exterior to the actinal furrow spinelets. The jaws rest in similarly shaped specialized fossæ, as in the 2 preceding species.

The furrow spinelets are similar to those of the 2 preceding species. There are 2 to a plate, and the tip is rounded or subtruncate, projecting well above the general surface. The actinal adambulacral spinelets are also flattened and obovate in outline, bent away from the furrow. They very nearly, or quite, touch the furrow spinelets, only 1 series, if any, of fine granules intervening. (Compare figure with *sclerodermus*.) These actinal spinelets are relatively larger than in either of the 2 preceding forms and lie closer together, only 1 or at most 3 series of very fine granules separating them. As noted above, the adambulacral granules are smaller than those of the actinal intermediate plates, while in the 2 preceding species the reverse is the case.

Madreporic body subcordiform or shield-shaped. Striations centrifugal, but very irregular and interrupted. The plate is perfectly flat, and is situated nearer the margin than the center. Anal aperture is surrounded by a number of much enlarged granules.

Color in alcohol, dull dark brown; in life unknown; evidently darker than either of the preceding forms.

Locality: Station 3982, vicinity of Kauai Island, 233–40 fathoms, coarse brown coral sand, shells; bottom temperature, 48.5°; 1 specimen, type no. 21178, U. S. National Museum.

This is a more typical *Ophidiaster* than either of the 2 preceding species, on account of the 8 rows of papular pores. The submarginal series of either side is ventrolateral rather than actinal. But this form nevertheless has 3 rows of actinal intermediate plates, and the actinal surface is rather flat, not arched, as in *lorioli*. The name refers to the fluted character of the rays.

Genus LEIASTER Peters.

Leiaster (subgen.) Peters, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April, 1852, p. 177.

Leiaster callipeplus, new species.

Pl. xxx, figs. 1, 1a; pl. xxxi, fig. 3.

Rays 5. R = 52 mm.; r = 8 mm.; R = 6.5 to 6 r. Rays not all equal; shortest 47 mm. Breadth of ray at base, 8 mm.; at widest part of ray, 9 mm.

Rays subcylindrical, slightly constricted at base; of a nearly uniform caliber throughout; slightly broader than high, abruptly tapering to a blunt point. Rays fairly short for genus. Abactinal surface of disk slightly convex; interbrachial angle acutely rounded. No pedicellariæ of any description.

The whole test is covered by a thick, tough, smooth skin, which in the living state very effectively hides the plates, but in a dried state shrinks and allows the plates to be clearly seen. The papular areas, which are large, form 8 longitudinal series along the arms, but are irregularly scattered and much smaller on disk. Of these 8 series 1 is situated on either side of the ambulacral furrow, another on either side between the 2 marginal rows of plates, while the remaining 4 are on the convex abactinal surface. The actinal areas have 6 to 10 papular pores, the abactinal about 15, and all the pores are very small in alcoholic specimens. In many of the papular areas of dried specimens what appear to be 2 or 3 granules can be seen imbedded in the integument. The skeleton is composed of longitudinal,

usually regular, series of 4-sided plates with rounded corners and slightly excavated sides. These small plates imbricate in the longitudinal direction, and each is joined to its neighbor of the adjacent series by a transverse, much smaller ossicle, the series being separated from each other by about one-half the width of a plate. There are 7 rows of these larger plates; namely, a radial, an adradial, a superomarginal, and an inferomarginal. Adjacent to adambulacral plates is a row of small plates, of which 2 correspond to each inferomarginal plate, to which every pair of intermediate plates is joined by the usual transverse ossicle. The papular areas between the actinal and inferomarginal plates are smaller than the others. (Pl. xxx, fig. 1a.)

Adambulacral plates are much smaller than the actinal plates, and are set obliquely as regards their dorsoventral direction, the outer end of the proximal plate underlying the adoral end of the succeeding plate. The actinal surface of each plate is wider than long, and between the plates are conspicuous sutures, all being hidden by the thick skin. Armature consists of a furrow series of 3 short, equal, spinelets, flattened and with rounded tips. The spinelets stand nearly parallel, and are invested by a continuous membrane extending from the inner mouth spines to tip of ray. The edge of this membrane or skin is serrated by the tips of the spinelets. Surface of spinelets is plane, not grooved, on the inner side. On actinal surface of about every other plate is an upright, robust, slightly compressed spinelet about 1 mm. in length. It is invested, also, in membrane, except the rounded roughened tip. On actinal surface of mouth plates these spinelets are slightly larger (1.5 mm.).

Terminal plate of arm tubercular, armed with 3 or 4 minute granules or spinelets. Madreporic body circular, perfectly plane, situated rather nearer margin than midway between it and center of disk; marked by fine radiating striations. Anal aperture very inconspicuous except in dried specimens. It is surrounded by a number of minute spinelets, wholly obscured by the integument in alcoholic specimens.

Color in life: Abactinal surface and sides a deep maroon purple, with a decided magenta tint at the ends of arms. The purple tends somewhat to pansy purple, but is hardly so blue. Actinal surface maroon purple, the series of actinal adambulacral spinelets phlox purple. Tube feet deep cadmium yellow. In alcohol all the color is lost, and the specimen becomes a dirty faded yellow.

Localities: Type (no. 21179, U. S. National Museum) from station 4149, vicinity of Bird Island, 33–71 fathoms, coral and coralline; bottom temperature 77.7° (surface temperature 78°). Taken also at the following stations, in all, 8 specimens:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3872	Auau Channel, between Maui and Lanai islands	43–32	Yellow sand, pebbles, coral.
3875	do	65–34	Fine gray sand.
4128	Vicinity of Kauai Island	About 68	Coarse brown coral sand, foraminifera.
4164	Vicinity of Bird Island	40–56	Coral sand, pebbles, shells.

This strikingly colored starfish is a shallow-water form. The genus contains 5 other species: *L. coriaceus* (Peters), Querimba Island, Mauritius; *L. glaber* (Peters), Querimba Island; *L. leachi* (Gray), Mauritius; *L. speciosus* von Martens, off Flores and Fiji islands; *L. teres* (Verrill), La Paz, Lower California. The present species is apparently nearest *L. glaber* from Querimba Island, but the original description of Peters is too incomplete to lend much aid in determining the specific differences.

Genus LINCKIA Nardo.

Linckia Nardo, De Asteriis, Oken's Isis, 1834, p. 717. Type, *Linckia typus* Nardo = *Linckia lævigata* (Gmelin) 1788.
Cribrella Agassiz, Mem. Soc. Sci. Nat. Neuchâtel, t. 1, 1835, p. 191.

Key to Hawaiian species of Linckia.

a. Spinelets bordering ambulacral furrow alternately larger and smaller. Occasionally a third aboral granule is present in these adambulacral series; 2 madreporic bodies ..... *diplax*

aa. Spinelets bordering ambulacral furrow about equal, but separated by a perpendicular series of 4 or 5 granules; 2 madreporic bodies ..... *multifora*

Linckia diplax (Müller and Troschel).

Pl. XXIX, fig. 4; pl. XXXI, fig. 7.

Ophidiaster diplax Müller and Troschel, System der Asteriden, 1842, p. 40.
Linckia diplax, Lütken, Videnskabelige Meddelelser, 1871, p. 268.
Linckia pacifica var. *diplax*, Sladen, Challenger Asteroidea, 1889, p. 410.

A large specimen of this species was taken at station 3848, off the south coast of Molokai, to which may be added a small specimen from 3872, although the identity of the latter is not so certain. The large example has 4 arms and 2 madreporic bodies, and its dimensions are as follows: R=138–140 mm.; r=10–11.5 mm.; R=12–14 r. Breadth of ray at base about 14 to 15 mm.; at widest part, in middle, 17.5 mm. Ray about 9 times as long as breadth at base measured along one side of ray. Rays are considerably flattened in the central portion, narrower at the base and gradually tapering to a blunt extremity which is slightly upturned. Papular areas numerous, rather larger than individual plates but smaller on the disk. Pores 15 to 25, small. On the lateral face of the arm 3 more or less distinct regular longitudinal rows of plates can be distinguished. Between the lowermost of these series and the adambulacral plates are 3 longitudinal series of actinal intermediate plates, those of the innermost series largest. Granules of the abactinal area very fine, much larger on the convexity of the plate than in vicinity of papular pores. On the ventral surface the granules are much larger, polygonal, and increase in size toward the furrow. The adambulacral armature is in 2 regular contiguous series. The inner series is composed of rather flat, broad, usually spatulate spinelets, with heavy rounded tips, separated by a much narrower spinelet about two-thirds the length of the larger. The smaller alternates more or less regularly with the large spinelet. There may be also a third spinelet, very small, almost a granule, in fact, on the aboral end of the plate. This is not common, however. Frequently the "smaller" spinelet nearly equals the larger in length but is always narrower and not spatulate. The spinelets of the external series are contiguous with those of the inner and are less numerous, there being 1 to about every 2 of the furrow spinelets. They are slightly larger than the latter, are not greatly flattened, and their tips are thick and rounded. Outside of these there are indications of a third rather irregular series which may be easily confused with the general granulation of the actinal surface, except that the latter is polygonal, while the larger granules are more rounded. Though polygonal at times, they rise slightly above the general surface.

In the small specimen 3 of the 5 arms are regenerating and the second madreporic plate is almost rudimentary. R=33 mm.; r=4 mm.; R=8 r. Breadth of ray at base 4.5 mm. The arms are more cylindrical than in the large specimen. Papular areas are much smaller than the surrounding plates; pores about 6 to each area. The 3 lateral longitudinal series of plates are distinct. Adambulacral armature is as in the large specimen, but the outer or third series is quite distinct. The granulation is relatively coarser than in the larger example, and less crowded, especially on the actinal surface, so that the granules are globose rather than polygonal. In size this specimen is more nearly like *Linckia ehrenbergi* (Müller and Troschel), to which the papular areas, smaller than the plates, also would refer it, but it is probably to be looked upon simply as a young *diplax*.

The species which is nearest to *L. diplax* is *L. pacifica*, which differs in having but one madreporic body. *L. ehrenbergi* is also very similar, but the arms are shorter (R=7.5 r); also the spinelets of the actinal adambulacral series are said by P. de Loriol (Mém. Soc. Phys. et d'Hist. Nat. Genève, t. XXIX, 1885, p. 34) to be slightly larger than those of the furrow and equal in *diplax*. But in the Hawaiian specimen, which is out of proportion for *ehrenbergi*, the actinal spinelets or granules are slightly larger, or at least the exposed tip heavier, so that this character is hardly to be relied upon. *Linckia multifora* differs in the disposition of the adambulacral furrow spinelets, which are separated by a perpendicular series of 4 or 5 granules. The actinal spinelets are not contiguous with the furrow series, and are of about the same size as the latter. The general appearance of the 2 forms is very similar.

Perrier (Rév. Stell., p. 145) notes that *diplax* occasionally has 3 madreporic bodies.

Localities: Station 3848, south coast of Molokai Island, 44 to 73 fathoms, sand and gravel; 3872, Auau Channel, between Maui and Lanai islands, 43 to 32 fathoms, yellow sand, pebbles, coral.

Linckia multifora (Lamarck).

Asterias multifora Lamarck, Animaux sans vertèbres, t. II, 1816, p. 565.
? *Linckia typus* Gray, Ann. N. H., ser. I, vol. V, 1840, p. 284.
? *Linckia leachii* Gray, ibid., p. 285.
Ophidiaster multiforis, Müller and Troschel, System der Asteriden, 1842, p. 31.
Linckia multiforas, Gray, Synop. of the Species of Starfishes, 1866, p. 14. (Also *L. typus* and *L. leachii*.)

Linckia multiforis, von Martens, Ueber Ostasiat. Echinod. <Archiv. für Naturgesch., jahrg. XXXII, 1866, bd. 1, p. 65.
Ophidiaster multiforis, Edm. Perrier, Pédicellaires, 1869, p. 59.
Linckia multifora, Lütken, Videnskabelige Meddelelser, 1871, p. 267, and authors generally since then.

This species is recorded from the Sandwich Islands by Perrier (Révision des Stellérides, p. 150). No specimens were taken by the Hawaiian expedition.

It is not unlikely that with further search in shallow water other forms of *Linckia* may be brought to light. The genus is a rather difficult one. Most of the species look very much alike, so that it is not easy adequately to characterize them without the use of figures. Three well-known forms have not yet been figured (or at least not where the average student can find them). Since other species may subsequently be found in the Hawaiian Islands, I have ventured to compile from descriptions the following synoptical table of the common species of the genus. *Linckia multifora*, *ehrenbergi*, and *marmorata* are figured in P. de Loriol's "Catalogue Raisonné des Echinodermes de l'Isle de Maurice" (Mém. Soc. Phys. et d'Hist. Nat. Genève, t. XXIX, 1885), and *L. guildingi* (*L. ornithopus* of Müller and Troschel), an Atlantic form, in Agassiz's "North American Starfishes" (Mem. Mus. Comp. Zool., vol. v, no. 1, 1877).

Key to the commoner Pacific species of Linckia.

a. Furrow spinelets separated by several granules in a perpendicular series.

b. R=10–12 r. Arms 9 times as long as wide. Papular areas numerous, small, about the size of the plates, 6 to 12 pores. There is no median radial area free from papular areas. Two or 3 madreporic bodies.....*multifora*

(Red Sea, Mozambique, Mauritius, Ceylon, Larentuka, Celebes, Amboina, New Caledonia, Fiji, Samoa, and Hawaiian Islands.)

bb. R=6 r. Rays 5 times as long as wide. Papular areas rather large, superficially larger than the plates. There is a median radial area free of papular areas. One madreporic body.
lævigata (*L. miliaris*)

(Red Sea, Mozambique, Mauritius, Zanzibar, Ceylon, Madras, Andaman Islands, Flores, Timor, Celebes, Batjan, Philippines, N. Australia, Claremont Island, New Caledonia, Caroline, Fiji, and Samoan islands.

aa. Furrow spinelets not separated by several granules in a perpendicular series.

b. Only 1 madreporic body.

c. Two series of adambulacral spinelets contiguous.

d. R=8.3 r. Abactinal plates in 3 irregular series. A certain number of these plates, more prominent and generally rounded, form bosses or "nodosities" irregularly disposed. Papular areas small, with 8 pores, sunken. Furrow spinelets alternately large and small; the small are cylindrical, the larger broader at tip. The external series is composed of granules or spinelets contiguous with the furrow series, each situated opposite a smaller spinelet. They are slightly larger than the larger furrow spinelets. A third series is also present, larger than the other actinal granules and separated from the external adambulacral spinelets by a space covered with smaller granules.....*nodosa*

(Tortugas, Arafura Sea, Torres Strait, *fide* Bell.)

dd. R=10.6–12.5 r. Abactinal plates numerous and irregular, equal, not especially prominent, about the same dimensions as the papular areas. Adambulacral spinelets in 2 contiguous series, the inner consisting of alternately large and small spinelets. Those of external series are equal; slightly larger and less numerous than the inner series.
pacifica

(Mauritius, Nicobar Islands, Andaman Islands, Tahiti, Samoan Islands.)

cc. The 2 series of adambulacral spinelets separated by a granular area.....*marmorata*

(Mauritius, Prince of Wales Channel, Port Molle, Fitzroy Island.)

bb. Two or occasionally 3 madreporic bodies.

c. R=13 r. Length of ray=12 times width.....*diplax*

(Mauritius, Madagascar, Isle of Bourbon, Christmas Island, New Caledonia, Fiji, and Tonga islands, Hawaiian Islands.)

cc. R=7.5 r. Length of ray=7 times width.....*ehrenbergi*

(Red Sea, Mozambique, Mauritius.)

Genus NARDOA Gray.

Linckia (pars) Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss., Berlin, 1840, April, p. 103.
Nardoa Gray, Ann. N. H., ser. I, vol. v, Dec., 1840, p. 286.
Gomophia Gray, ibid.
Scytaster (pars) Müller and Troschel, System der Asteriden, 1842, p. 34. Lütken, Videnskabelige Meddelelser, 1864, p. 163. Perrier, Révision des Stellérides, 1875, p. 156.
Ophidiaster (pars) Müller and Troschel, System der Asteriden, 1842, p. 28.
Nardoa Sladen, Challenger Asteroidea, 1889, p. 411. Type *Asterias variolata* Retzius (the *Asterias variolata* of Lamarck, and *Linckia variolata* of Nardo and of Agassiz).

Nardoa ægyptiaca (Gray).

Gomophia ægyptiaca Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 286.
Scytaster ægyptiacus Perrier, Révision des Stellérides, 1875, p. 164.
Nardoa ægyptiaca Sladen, Challenger Asteroidea, 1889, p. 788.

Recorded by Sladen (l. c.), from the Sandwich Islands. I have been unable to find the original record. This species was not taken by the *Albatross* expedition.

Family GYMNASTERIIDÆ Perrier, 1884, emended.

Gymnasteriidæ Perrier, Mémoire sur les Étoiles de Mer, etc. <Nouv. Archives Mus. Hist. Nat., 2e sér., t. VI, 1884, p. 165.

Genus GYMNASTERIA Gray.

Gymnasteria Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 278. Type, *Asterias carinifera* Lamarck.
Asteropsis (pars) Müller and Troschel, System der Asteriden, 1842, p. 62.

Gymnasteria carinifera (Lamarck).

Asterias carinifera Lamarck, Animaux sans Vertèbres, t. II, 1816, p. 556.
Gymnasterias carinifera v. Martens, Archiv. f. Naturg., Jahrg. XXXII, Bd. 1, 1866, p. 74.

This species is recorded from the Sandwich Islands by Perrier (Révision des Stellérides, p. 286), the specimens being in the British Museum. Sladen likewise records it in the report on the starfishes collected by the *Challenger* expedition (p. 357), very likely from the same specimens. No examples were secured by the *Albatross* expedition.

Order SPINULOSA Perrier emended.

Family ASTERINIDÆ Gray, 1840 (emended).

Asterinidæ Gray, Synopsis of the Genera and Species of the Class *Hypostoma* (*Asterias* Linn.). <Ann. N. H., ser. I, vol. VI, 1840, p. 288. Emended by Perrier, Révision des Stellérides, 1875, p. 289; and in Mission Scientif. du Cap Horn, Echinodermes, 1891, p. 107.
=Asterininæ Sladen, Challenger Asteroidea, 1889, pp. 376, 384, or the Asterinidæ, less Ganeriinæ and Palmipedinæ.

Genus ASTERINA Nardo.

Asterina Nardo, De Asteriis, Oken's Isis, 1834, p. 716. Type (?) *Asterina gibbosa* (Pennant). *Asterina minuta* (Olivi) Nardo=*Asterias gibbosa* Pennant.

Asterina granulosa Perrier.

Asterina granulosa Perrier, Révision des Stellérides, 1875, p. 312. J. E. Ives, Proc. Phil. Acad. Sciences, 1889, p. 173.

The specimens upon which the species is based were collected by M. Ballieu in the Sandwich Islands in 1874. The only other direct reference which I have been able to find is that of J. E. Ives (l. c.), who records one specimen from Oahu, collected by Dr. W. H. Jones. No examples were secured by the *Albatross* expedition.

Family ANSEROPODIDÆ[a], new.

= Subfamily Palmipedinæ Sladen, Challenger Asteroidea, 1889, p. 394.

[a] By those who do not believe that this group constitutes a family the name Anseropodinæ must be used, instead of Palmipedinæ, *Palmipes* being a synonym of *Anseropoda*.

Genus ANSEROPODA[a] Nardo.

Anseropoda Nardo, De Asteriis, Oken's Isis, 1834, p. 716. Type *Anseropoda membranacea* = *Asterias placenta* Pennant.
Palmipes L. Agassiz, Mem. Soc. Sci. N. Neuchâtel, t. I, 1835, 192.

Anseropoda insignis, new species.

Pl. XXXVIII, figs. 1–1a.

Rays 6. R = 121 mm.; r = 100 mm. R = 1.2 r. A larger but less perfect specimen measures R, 127 mm.; r, 97 mm. R, 1.3 r.

The rays are thus very short, but have a well-rounded, leaf-like contour, the interbrachial arcs being also rounded. Tip of ray more or less indented. Body very thin and flat, slightly convex in center of disk, there being an abrupt, slightly elevated, rounded ridge along each medio-radial line.

Abactinal plates of interradial areas bear 1 fairly large tuft of very delicate, sharp spinelets, with usually 1 to 3 or more tufts of smaller size around it. On interradial areas of outer half of disk there is usually but one tuft of about 7 to 10 spinelets, situated rather nearer the inner edge of plate than the center of exposed surface. Then, regarding toward radial areas and center of disk, there are added at either side first 1 and then 2 additional smaller tufts, which have 4 or 5 spinelets, while the large tuft has 7 to 10 or more. Occasionally the 3 merge and form a larger irregular tuft. Toward central portion of disk there are often 4 tufts of nearly equal size, with about 8 to 10 spinelets in each, situated on the four corners of a plate, with several groups of 1 to 3 spinelets scattered between. Other plates are irregular as to their armature, and the larger plates of the central or slightly elevated portion of disk have as many as 15 to 20 tufts of various sizes, mostly well spaced, and easily counted, but very irregular as to position. All spinelets are very delicate, sharp, and small, and are usually directed away from center of disk. On either side of median radial line there is a single series of numerous papulæ, which do not quite reach to tip of ray nor to center of disk. The 2 series of a ray are separated by 2 longitudinal series of plates, larger than those immediately adjacent. They also bear more tufts of spinelets, usually 5 to 6.

Adambulacral plates are rather short, with a convex margin to furrow. Armature as follows: (1) A furrow series of 5 or 6 (rarely 4) delicate spinelets, united for over half their length by a thin web. They form a fan-shaped series, the median spinelet being slightly longer than the laterals. Sometimes the adoral spinelet, or less commonly, the aboral, is about two-thirds the length of the others, which are nearly equal. (2) On actinal surface of the plate a group of about 10 spinelets, united by a web and disposed in a curvilinear series, which is more easily understood form the accompanying figure (pl. XXXVIII, fig. 1) than from description. A portion of this series—that nearest furrow—is usually directed backward, covering the outer spinelets of the group.

Mouth plates are fairly large, rather narrow outwardly. The armature consists of a marginal row of about 8 flattened, blunt spinelets, the basal half constricted and united by a thin web. They increase in size toward the inner angle, the innermost 3 to 4 spinelets being fairly stout, compressed and truncate. On actinal surface there is a double series of about 12 to 30 slenderer spinelets, extending lengthwise of the plate, or in a group of 5 or 6 parallel with furrow spinelets, the remainder, somewhat smaller and more delicate, being on the outer part of plate. There is much irregularity in the disposition of these spinelets.

Actinal plates bear a regular and ornate comb of delicate spinelets, connected for two-thirds or three-fourths their length by a thin but resistant web. The plates, and consequently the spines, decrease toward margin, and from the ambulacral furrow toward median interradial line. The innermost plates bear a series of 10 to 14 spines. Midway to extremity of ray, adjacant to furrow, there are about 9, but midway on the interradial line there are but 7 or 8, considerably shorter. Near margin the number is further reduced to 5 or 6. The median spinelets are longest and all radiate, forming planate series.

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[a] This genus has usually been called *Palmipes*. *Palmipes*, however, was not used by a post-Linnæan writer until a year after *Anseropoda* Nardo. It seems somewhat discouraging in the first years of the twentieth century to be obliged to call attention to the fact that Linck (1733), who first used *Palmipes* and who was quoted in the last extensive paper on European starfishes as the authority for the name, was in no way a binomial writer, and that consequently his so-called genera (!) have no place even if 1758 had not been agreed upon as the starting point of zoological nomenclature. For a statement of the facts in the present case see Prof. F. Jeffrey Bell in Annals of Natural History, ser. 6, vol. VII, 1891, p. 233. The Rev. Canon A. M. Norman (op. cit., p. 382) admits that *Anseropoda* has priority, but objects to its use because it happens to be etymologically a hybrid. What would happen if all generic names which confess this fault were thrown out for the same reason?

Marginal plates are very small. The plates which probably represent the superomarginals are larger than adjacent abactinal plates, and are placed without reference to the regular rows of the latter. They bear a tuft of minute spinelets. The inferomarginals are larger than superomarginals, and likewise bear a glomerular tuft of minute spinelets. Both series resemble tiny paxillæ.

Madreporic body small, situated near center of disk. Striations coarse, irregular, radiating. Anal opening subcentral 8 to 9 mm. from madreporic body. Ambulacral feet with small sucking disks.

Color in life: Upper surface bright vermilion, with a madder-pink cast, the 6 radial ridges intense scarlet vermilion. Actinal surface scarlet vermilion, a large area in central part of disk cream color, slightly spotted with vermilion. Edge of ambulacral furrow slightly more yellowish than rest of light patch. Ambulacral feet translucent yellowish brown (raw sienna).

Variations: A small specimen (R=35 mm.) is essentially like the large individuals. Most of the plates of the abactinal interradial area bear but 1 tuft of spinelets, 7 to 10 in number, and widely radiating. The larger plates of central portion of disk bear 4 to 8 tufts. Mouth plates shorter than in adult, and the furrow spinelets much slenderer, 5 to 6 in number, and united by a web. Actinal mouth spines fewer. Adambulacral furrow spines 5 or 6 at base of furrow, 3 or 4 on outer part.

Localities: Type (no. 21180, U. S. National Museum) from 4101, Pailolo Channel, between Mauai and Molokai islands, 143–122 fathoms, coral sand, shells, foraminifera; bottom temperature 59.7°; 3 specimens. Taken also at 3835, south coast of Molokai, 169–182 fathoms, fine brown sand and mud; 1 specimen.

This remarkable starfish, which is a true *Anseropoda*, is perhaps the oddest species in the Hawaiian collection. Like its congeners, it is literally flatter than a pancake, which character, added to its brilliant coloring, gives it a truly bizarre appearance. The animal is very delicate on account of its extreme thinness. All the specimens are more or less injured, but the type is entire. *Anseropoda insignis* is probably nearest *A. placenta* of the Mediterranean region. It differs, however, in having constantly 6 rays, and in details of adambulacral and abactinal armature. *A. rosacea*, from Japan and the Bay of Bengal, is a fifteen-rayed form, which likewise differs in its armature. *A. diaphnea* (Sladen) and *A. pellucida* (Alcock) are apparently widely different forms.

This species evidently feeds largely upon shrimps, for the stomachs of 2 individuals are crammed with these small crustaceans ranging from 5 to 25 mm. in length. It would be interesting to learn in what manner the prey is secured.

Family ECHINASTERIDÆ Verrill, 1871, emended.

Echinasteridæ Verrill, Trans. Conn. Acad., vol. I, 1867, part 2, p. 343.

Key to Hawaiian genera of Echinasteridæ.

a. Disk small. Spinulation small. Spinelets isolated or grouped. No pedicellariæ.
b. Abactinal plates bearing small spinelets in more or less compact groups ..... HENRICIA
bb. Abactinal plates bearing simple isolated spines ..... ECHINASTER
aa. Disk moderately developed. Rays 5. Abactinal plates plates regularly disposed, having small isolated spinelets. Marginal plates with large valvate pedicellariæ. Actinal intermediate plates bearing one or more large flattened spinelets ..... VALVASTER

Subfamily ECHINASTERINÆ VIGUIER, 1878.

Echinasterinæ Viguier, Anatomie Comparée du Squelette des Stellérides. <Archiv. Zool. Expér. et Génér., t. VII, 1878, p. 123 (separate).

Genus HENRICIA Gray.

Henricia Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 184. Type *Asterias sanguinolenta* O. F. Müller.
Linckia Forbes, nec Nardo, Mem. Wern., vol. VIII, 1839, p. 120.
Cribrella Forbes, nec Agassiz, British Starfishes, 1841, p. 106.
Cribrella, Lütken, Grönl. Echinod., 1857, p. 30; and most other authors up to present day.
Echinaster, Müller and Troschel, System der Asteriden, 1842, p. 22 (pars).
Henricia, Bell, Ann. N. H., ser. 6, vol. VI, 1890, p. 472.

Prof. F. J. Bell (op. cit.) has explained why the name *Cribrella* can not be used for this genus. Since few writers have cared to follow the ordinary rules of nomenclature in this case, however, it may be well to state again why *Cribrella* has no status in nomenclature.

L. Agassiz (Prodrome d'une Monographie des Radiares ou Echinodermes, Mém. Soc. Sci. Nat. Neuchâtel, t. 1, 1835, p. 191) wrote as follows:

LINCKIA Nardo.—*Cribrella* Ag. Msc.—Corps étoilé; rayons tuberculeux et allongés; peau poreuse dans les intervalles. *L. variolata* N. (Asterias variol. Lam.)—*L. Typus* N.—*L. Franciscus* N. Les especes décrites par Goldf. sous les noms d'*Asterias arenicola* et *abtusa*, semblent devoir former un genre à part que l'on pourrait nommer PLEURASTER. Je ne les connais cependent pas assez pour en decider.

It is very evident that *Linckia* and *Cribrella* were the same in Agassiz's mind. In other words, *Cribrella* must be treated as a substitute name for *Linckia* Nardo, and since *Cribrella* is based on *Linckia* the type of *Linckia* is the type of *Cribrella*. If *Linckia* should become invalidated, *Cribrella* could replace it; otherwise *Cribrella* can never have any standing other than as a synonym of *Linckia*. Even if none of the species given above were congeneric with *Linckia* of Nardo [but *L. typus* is the type of *Linckia*], or even if it could be proved that Agassiz never saw a specimen of true *Linckia*, the case would not be altered. If a writer bases one genus upon another intentionally or unintentionally, the type of the old genus becomes ipso facto the type of the new one.

It appears, therefore, that Forbes's appropriation of the name *Cribrella* for the group previously named *Henricia* by Gray has no justification. *Cribrella*, as a matter of fact, has nothing to do with this group. It is simply a synonym of *Linckia*. Canon Norman (Ann. N. H., ser. 6, vol. VII, p. 382) contends that "Agassiz first used the name; that Forbes more accurately defined the genus." Agassiz left no doubt as to what he meant by *Cribrella*, so that Forbes did not better matters by transferring the name to another and previously named genus.

Key to Hawaiian species of Henricia.

a. Rays short and thick ..... *robusta*
b. Rays long and slender ..... *pauperrima*

Henricia robusta, new species.

Pl. XXXV, figs. 1, 2; pl. XXXVIII, figs. 2, 2a.

Rays 5. R=31 mm.; r=6 mm. R=5 r. Breadth of ray at widest part, near base, 8–9 mm. Rays unequal, the shortest with R=26 mm.

Rays short and stout, swollen at base, and thence tapering to a blunt extremity which is recurved. The whole animal is slightly depressed, so that the rays are not cylindrical except near tip, but are rather elliptical in section, and are constricted next to disk, a shallow sulcus running part way toward center of disk from each interradial angle. The disk appears rather small in consequence.

Plates of the abactinal surface are very small, and are so arranged as to form an open network, inclosing fairly large, irregular papular areas. These plates are crowded with groups of 3–8 minute, delicate, slender, short, cylindrical, often slightly tapering, spiculiform spinelets. There is no constant arrangement of these spinelets, although occasionally a biserial grouping is discoverable. Often they form an irregular circular group. The papular areas, which are sunken considerably, are often broken up by isolated plates, or 2 or 3 plates together, bearing tufts of spicules.

Low on the lateral wall, which is rounded, is a narrow, rather irregular longitudinal line, which rises toward interbrachial angle. This is composed of longitudinally disposed plates a trifle larger than the others, each crowned with 14 or 15 of the slender spinelets. Below this series is a similar line of smaller, transversely disposed plates, which is succeeded by still another longitudinal series, with long axis of plates likewise transverse. These bear about 15 spinelets disposed in 2 or 3 irregular transverse rows. The first series, which has been considered the superomarginal, is slightly more conspicuous than the lower (inferomarginal) because its plates are nearer together, being placed end to end. Between superomarginals and adambulacrals the plates are arranged in definite transverse series, except at very base of the ray, where there is irregularity. Between the inferomarginals and adambulacrals one can count 5 or 6 plates to each transverse series at base of ray. These are reduced to 2 at the end of the proximal third of ray, and to 1 at about the middle. The single longitudinal series of intermediate plates continues for two-thirds to three-fourths the length of the ray. These actinal plates are beset with slender spinelets like those of the dorsal plates. In some cases a delicate web can be distinguished uniting the basal half of several adjacent spinelets.

Armature of adambulacral plates as follows: (1) A short compressed spinelet placed high up on side of furrow. (2) On actinal surface of plates at base of ray, 3 or 4 larger, cylindrical, slightly taper-

ing spinelets, arranged with 1 on furrow margin and 2 behind in an oblique or longitudinal series; or when there are 4, 1 on margin, followed by 1 directly behind it, and the two outer in an oblique series. Occasionally the 4 are grouped on the inner half of plate, without definite order. On outer part of plate there is a group of 7 to 10 much smaller, subclavate spinelets, slightly larger than those of adjacent actinal intermediate plates. They are well spaced, and increase in length toward furrow. Further along ray the arrangement is usually 1 spinelet on the furrow edge and behind it, 2, a trifle shorter, in a longitudinal series. A fourth spinelet is sometimes present, external to these. On the outer side of plate are 5 or 6 unequal, smaller spinelets, their bases united by membrane.

Madreporic body of medium size, circular, situated at the summit of an interradial sulcus. Striations few, coarse, radiating, with wide sulcuses between the ridges. The latter are studded with numerous spinelets, like those of neighboring plates. Anal opening eccentric, prominent.

Color in life, a soiled cream color.

Locality: Type (no. 21181, U. S. National Museum) from station 4115, northwest coast of Oahu Island, 195–241 fathoms, coral sand, foraminifera; bottom temperature 55.1°.

This species is characterized by its thick, short rays, and generally robust form, by the uncrowded condition of the plates which form a network, by the numerous delicate spicules forming groups on these plates, and by the adambulacral armature. The species is most nearly related to *Henricia obesa* (Sladen) from the Falkland Islands and Straits of Magellan, from which it differs in details of its spinulation and in the armature of the adambulacral plates. The spines of the body are much more delicate in *robusta* than in *obesa*, and are more numerous.

Henricia pauperrima, new species.

Pl. xxxv, figs. 3, 4; pl. xxxviii, fig. 3, 3a–b.

Rays 5. R=61 mm.; r=9 mm. R=6.7 r. Breadth of ray at base, 9 mm.; at 10 mm. from base, 6 mm. Rays unequal, the shortest (possibly mutilated) 40 mm.

Rays long and very slender, cylindrical, tapering continually from a narrow base to a prolonged, bluntly pointed extremity. Disk fair sized, somewhat inflated. Interbrachial angles obtuse or rounded.

Plates are larger and more crowded than in the foregoing species. They are small and form a close network which is very irregular. Abactinal surface, however, appears quite porous, the plates being in nowise so crowded as in *leviuscula* or *sanguinolenta*. Papulæ are large and isolated, surrounded by small plates, which bear 8 to 12 minute, very delicate and sharp, well-spaced spinelets. These are much more delicate than those of last species and can not be distinguished without a glass. Smaller plates may bear only 4 or 5 spicules, which, however, are always spaced, not in compact groups.

Adjacent to the adambulacral plates is a series of plates slightly larger than the lateral and abactinal plates, and like them bearing delicate spinelets. On the outer two-thirds of the ray a continuous series of smaller (superomarginal?) plates is present, and between the 2 is a very definite line of papulæ which extends to mouth angle. Actinal interradial plates are rather larger than abactinals.

Adambulacral plates are rather large, only a trifle broader than long. Armature as follows: (1) 2 delicate, slender spinelets, placed one above the other high on furrow wall, the upper being at apex of plate. (2) On actinal surface 3 rather long, slender spinelets, spaced on edge of furrow, 1 in the center being longest. Just behind these, at the base of ray, 2 to 4 additional spinelets often stand in a longitudinal row, and occasionally farther along the ray there will be 1 or 2 much smaller spinelets. The outer two-thirds of the plate is covered with 10 to 15 delicate, minute, well-spaced spinelets or spicules, similar to those arming other plates of the body.

Madreporic body fairly large, with a few coarse, irregular, narrow ridges separated by deep sulcuses. Ridges bear minute spinelets. Body is situated nearly midway between center of disk and margin when the specimen is viewed directly from above.

Color in life, very pale greenish-gray or dirty white; ambulacral furrows darker greenish-gray.

Localities: Type (no. 21182, U. S. National Museum) from station 4166, vicinity of Bird Island, 293 to 800 fathoms, coral sand, foraminifera, rocks; bottom temperature 45.6°. A young specimen probably belonging to this species was taken from 4044, west coast of Hawaii, 233 to 198 fathoms, fine gray sand.

This species is remarkable for its very slender rays, and curiously formed disk. It is probably most closely related to *Henricia compacta* (Sladen), from the west coast of New Zealand (275 fathoms), but differs from this form principally in the adambulacral armature. *H. pauperrima* may be readily distinguished by the 2 small spines placed on the side of the ambulacral furrow (pl. XXXVIII, fig. 3b), there being in this genus usually only 1.

Genus ECHINASTER Müller and Troschel.

Echinaster Müller and Troschel, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, April, 1840, p. 102. Type (?) *Echinaster sepositus* (Lamarck).

Echinaster, sp.

Of the 2 species of *Echinaster* in the collection, 1 is represented by 2 specimens, the other by but 1. The first species is too young for specific determination. One of the examples was taken at station 3872, Auau Channel, 43 to 32 fathoms, yellow sand, pebbles, coral; the other at station 4162, Bird Island, 21 to 24 fathoms. R = 13 mm., r = 2.75 mm. The plates are relatively large, cordate, and arranged on rays in a radial, adradial, supero- and inferomarginal and 1 actinal intermediate series. The primary apical system is conspicuous. In the smaller of the two specimens most of the plates have a short stubby spinelet. Furrow adambulacral spinelets 2, short, the aboral slightly the shorter; arranged in a linear series, the whole of which from end to end of the ray is invested in a very delicate membrane. On the actinal surface of every adambulacral plate is a robust, short, stubby, lanceolate spine directed away from furrow. On outer part of ray alternate plates are often without actinal spines. Actinal intermediate plates much smaller than inferomarginals, oval in shape, and about as large as adambulacral plates. Single madreporic body. Rays 5.

Color in life: Light buff, yellow at tips of rays, which are mottled above with burnt sienna. The rays are also marked with transverse scalloped lines of the same color, which follow the adoral overlapping edges of the plates and give a very scaly appearance to the creature.

The other species is larger and is almost undoubtedly new, but is in rather too poor condition to constitute a type. It is closely related to *Echinaster sladeni* de Loriol, from Mauritius.[a] Rays 5. R=32 mm.; r=5 mm. R=6.4 r. Rays considerably flattened, somewhat constricted at base, tapering to a blunt point; practically the same shape as *E. sladeni*. There are 7 longitudinal series of 4-lobed plates, of which the marginal series is constantly most regular. Each plate, with few exceptions, bears a robust, sharp spinelet only very microscopically striated. Between adambulacral and inferomarginal series are 2 rows of small rounded plates, the outer series corresponding plate to plate with the inferomarginals, while there are 2 plates of inner series to each of the outer. Papular areas about size of plates, containing only 1 or 2 papulæ. Adambulacral plates short, band-like. Furrow spinelets 2, rather delicate, slender, blunt, tapering very slightly. They are united for most of their length by a very delicate membrane which is continuous throughout ray. On actinal surface is a robust, slightly flattened, tapering, bluntly pointed spine, somewhat larger than those of inferomarginals. Occasionally a plate is missed, and on the outer part of ray usually only alternate plates possess an actinal spine. Madreporic body single.

Locality: Station 4046, west coast of Hawaii, 147 to 71 fathoms, coral sand, foraminifera.

It is possible that the preceding species is the very young of this form. The present species differs from *sladeni* in having a thicker skin, stouter spinelets which do not appear to be striated as in the Mauritius species; very much heavier actinal adambulacral spines, and more cylindrical, blunter furrow spinelets, which are, moreover, webbed. The 2 series of adambulacral spines will distinguish this species from *E. gracilis*, *E. eridanella*, and the other Indian and Pacific forms, if taken in connection with the thinnish skin and regular rows of plates.

Subfamily VALVASTERINÆ Viguier, 1878.

Valvasterinæ Viguier, Anatomie Comparée du Squelette des Stellérides. <Arch. Zool. Expér. et Génér., t. VII, 1878, p. 131 (separate).

Genus VALVASTER Perrier.

Valvaster Perrier, Révision des Stellérides, 1875, p. 112. Type, *Asterias striata* Lamarck.

[a] Mem. Soc. Phys. et d'Hist. Nat. Genève, t. XXXII, pt. 1, 1894, p. 61, pl.

Valvaster striatus (Lamarck).

Pl. XXXVIII, figs. 4, 4a.

Asterias striata Lamarck, Animals sans Vetrebres, t. III, 1816, p. 253.
Valvaster striatus, Perrier, Révision des Stellérides, p. 112, q. v. for complete synonomy.

This species was not taken by the *Albatross* in 1902, but a specimen was secured in 1891 at station 3469, south coast of Oahu Island, in 14 fathoms, on sand and coral.

A very good figure, with critical and descriptive notes, is given by P. de Loriol in "Catalogue Raisonné des Echinodermes recueillis à l'Isle de Maurice" (II. Stellérides), published in Mémoirs de la Société Physique et d'Histoire Naturelle de Genève, t. XXIX, 1885, p. 11, pl. VIII.

Rays 5. R=50 mm.; r=18.5 mm. R=2.8 r. Breadth of ray at base about 22.5 mm. General form depressed and flattened. Interbrachial arcs angular. The whole surface of the body is covered with short robust spines and spinelets, which are sharp on the abactinal surface but more blunt and often rounded, truncate, and flattened on the actinal. The characteristic feature of the species is a series of very large superomarginal, valvate pedicellariæ, surrounded by acicular spinelets, bordering the abactinal area.

Abactinal surface slightly inflated and the plates, which are arranged in regular network, leaving triangular, rather small, papular spaces, are not superficially evident in the alcoholic specimen. They are covered with sharp, conical spinelets, each of which is enveloped in a pulpy membraneous investment, so that neighboring spinelets appear to touch, and do not appear isolated as in the dried specimen figured by de Loriol. A median radial and 2 parallel series of spinlets on either side are slightly more prominent than the others. The small papular areas have fewer pores than de Loriol's specimen, only about 3 to 5. The abactinal membrane is granulous.

The superomarginal plates visibly define the border of the ray. Nearly all of them bear a long bivalved pedicellaria which occupies the whole length of plate and is surrounded by small, sharp, slightly curved acicular spinelets invested by a pulpy membrane which obscures entirely the encased spinelets. In interbrachial angle and at extremity of ray, a few plates lack the pedicellaria and bear an enlarged spinelet surrounded by granules and small, sharp spinelets.

Actinal plates bear each a flattened, stout, sharp, blunt, or truncate spine, much larger than the dorsal spinules. These spines, which are encased in membrane, are surrounded by 2 to 5 unequal, much smaller acicular spinelets, which are so sheathed in membrane as to appear broadly conical. The smallest of these spinelets is one-third the size of the largest, and there are likewise still smaller granules, especially in the interradial region. There are 5 longitudinal rows of the spines at base of ray, then 4 and 3, and on the outer third of ray 2. Inferomarginal plates each bear a stout, tapering, flattened spine, larger than the actinal spines, surrounded by a number of membrane-invested small acicular spinelets, 1 or 2 of which are usually larger than the others. Rarely a second spine stands on the same plate with the first. In de Loriol's specimen from Mauritius 2 spines were usual, and occasionally 3. Each adambulacral plate, clearly distinct from its neighbor, bears a furrow series of 5 spinelets at base of ray, becoming reduced to 3 on the outer portion. They form a fan, the aboral spinelet being equal to the third and the spinelet between them a trifle longer, while the fourth and fifth are decreasingly shorter than third. They are united by membrane for one-half to two-thirds their length, and are slender, the longest being about 1.75 mm., the shortest 0.25 mm. On the actinal surface of plate stands a truncate, flattened, slightly tapering, much stouter, and longer (2.5 mm.) spine similar to those of actinal intermediate plates. Two or 3 granules and a small, sharp spinelet stand close to its base in the outer end of plate. On a number of the proximal plates of series a small, upright, blunt forficiform pedicellaria takes the place of the shortest spinelet. A very few plates have a sixth spinelet or granule added to the adoral end of the series.

Madreporic body small, and situated nearer the center of disk than midway to margin. Striations very fine.

The specimen was partially dried after the characters had been noted in the alcoholic condition. In this way the granules of the abactinal surface became at once evident, and likewise a very few small forficiform pedicellariæ. The character of the abactinal surface agrees very well with de Loriol's figures, except that the spines are a trifle stouter than in the Mauritius specimen, and, since our specimen is smaller, the papular pores, as already noted, are fewer. The actinal spines of the Hawaiian example are not so broadly truncate, but are frequently slightly tapering and even bluntly

pointed. The accompanying spinelets appear a trifle larger and stouter in proportion to spine. The furrow spinelets are slightly stouter than in de Loriol's specimen, and there is usually but 1 acicular spinelet accompanying the actinal adambulacral spine. De Loriol does not mention the furrow pedicellariæ, which are present in the Hawaiian specimen. Some of these differences, all of which are slight, may be due to age, but more likely to the widely separated localities.

Valvaster striatus in another widely distributed form. It is found at Mauritius, but there is a great scarcity of records for points intermediate between that island and the Hawaiian group, for I have been unable to find any.

Family MITHRODIIDÆ Perrier, 1894.

Mithrodidæ[a] Perrier, Expéd. Travailleur et Talisman, Echinodermes, 1894, p. 4.
= Mithrodiinæ Viguier, Anatomie du Squelette des Stellérides. <Arch. Zool. Expér. et Génér., t. VII, 1878 (1879), p. 128.

Genus MITHRODIA Gray.

Mithrodia Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 287. Type, *Mithrodia spinulosa* (=*Asterias clavigera* Lamarck).

Hercsaster Michelin, Révue Zoologique, 1844, p. 173.

Mithrodia bradleyi Verrill.

Pl. XXXVI, figs. 1, 2; pl. XXXVII, figs. 1, 2, 3.

Mithrodia bradleyi Verrill, Trans. Conn. Acad., vol. 1, 1869, p. 288.
Mithrodia clavigera Perrier, Révision des Stellérides, 1875, p. 817; see also p. 337. J. E. Ives, Proc. Philad. Acad. Sci., 1889, p. 171.

This peculiar type is a rather common inhabitant of coral sand and rocks in shallow water, but so far as our experience goes is not found on exposed reefs anywhere in the Hawaiian group. Nearly all the specimens were taken with hempen tangles from bottom too rough for dredging nets. On account of the stout, rough spines with which the sides of the body are beset this method of collecting proved very successful, a considerable number of perfect specimens having been secured. These exhibit some variation not altogether due to difference of age.

The largest example has a major radius of 230 mm., or a diameter of about 450 mm. Not all the rays are of equal length, one being larger than all the rest. The shortest ray is about 198 mm. Inequality of rays seems to be a characteristic of the species. There are generally 5 rays, but one small specimen has 4 and another 6.

Rays subcylindrical, broader than high, except in young specimens where dimensions are nearly equal; distinctly narrowed at base and constricted next to the very small disk. R=about 14 r, but in one large specimen the ratio is as low as 1 to 8.5 or 9. The whole animal is covered with a tough integument beset with rather sharp granules, beneath which are the plates, so arranged that the surface of the body is marked off by coarse ridges forming a sort of network, which isolates triangular, roundish, or irregular areas containing the papulæ and covered with tiny scattered granules. The ridges are thrown into little knobs or prominences which vary considerably in number and proportions. As a rule they are more numerous in large specimens, often so much so as to destroy the mesh-like appearance of the ridges, which are covered with low, conical, crowded granules that give a very rough, rasp-like texture to surface. There are no prominent spines on the dorsal surface except in young specimens and very rarely in medium-sized specimens. In the former there is usually a median radial series of 6 or 8 widely spaced, rigid, subconical, or elongate thimble-shaped spines covered with sharp, scale-like granules. The granules or asperities on summits of the lower knob-like eminences, as well as those of the spine-tips, are larger and sharper than the others. There are regularly in old and young 3 longitudinal rows of cylindrical rigid spines, like those just described, on either side of the body, 1 on the margin or lateral face of ray, and the other 2 on the actinal surface. In adults the spines of the lateral series are least numerous, while those of the innermost ventral series are most numerous as well as slightly the smallest. In small and medium-sized examples there is not much difference between the middle (or outer ventral) and inner series, while in some adults there is considerable difference. These spines are slightly tapering and the membranous integument covering them is invested, like that of remainder of body, with squamiform,

[a] Although Perrier considered this an independent family in 1884 (Mém. sur les Etoiles de Mer, p. 164), he wrote the name "Mithrodinæ."

pointed granules, larger and more crowded at tip than at base. In 1 specimen a secondary row of enlarged tubercles intervenes between the 2 actinal rows of spines.

Each adambulacral plate bears a prominent cylindrical, blunt, upright spine on the actinal surface. These form a regular, close series at border of furrow, and are slenderer, slightly shorter and much more numerous than the adjacent spines of inner actinal series. (In young specimens the difference between the 2 series is very marked.) They taper very slightly, have rounded tips, and are covered with squamiform granules, which increase in size toward extremity of spine; but on side toward furrow there are no granules except at the very tip, the surface being smooth. Furrow series is placed directly at the base of the large actinal spine and consists of 6 to 9 or 10 slender spinules, united for their whole length by a fairly tough membrane and forming thus a fan with a very convex margin. The 3 or 4 central spinules are much the longest, the outermost of each series being very short indeed, especially when there are 8 to 10 spinelets to each fan.

Madreporic body is of medium size, with rather fine, interrupted striations. It is situated about midway between center and margin of disk, and in the larger specimens is nearly completely obscured by protuberances of the test.

The color of the live animal varies somewhat. One medium-sized individual was uniform vermilion except ambulacral furrow, which is yellow ocher. A large specimen was colored as follows: Papular areas dull brownish or reddish gray (a sort of pinkish sepia); abactinal surface of arms with 6 or more dark, or brownish, cross bars; the tubercles of lighter bars light vermilion; on the dark cross bars, deep vermilion. On actinal surface no barring visible, the tubercles and spines being all bright vermilion. Suckers of tube feet, yellow.

Localities: Thirty-six specimens were taken at the following localities, station 4024 with 9 being most prolific.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3847	South coast of Molokai	23–24	Sand, stones.
3871	Auau Channel between Maui and Lanai	13–43	Fine white sand.
3872	....do	43–32	Yellow sand, pebbles, coral.
3876	....do	28–43	Sand, gravel.
3960	Vicinity of Laysan	10–19	Sand, shells, coral.
3975	Necker Island Shoal	16–171	Coarse sand, coral, shells.
3978	Vicinity of Bird Island	32–46	Coral sand, foraminifera, rocks.
4024	Vicinity of Kauai	24–43	Coarse coral sand, foraminifera.
4034	Penguin Bank, south coast of Oahu	28–14	Fine coral sand, foraminifera.
4046	West coast of Hawaii	147–71	Coral sand, foraminifera.
4062	Northeast coast of Hawaii	83–113	Coral, volcanic sand, shells.
4146	Vicinity of Bird Island	23–26	Coarse coral sand.
4159	....do	30–31	Coarse coral sand, broken shells, foraminifera.
4160	....do	31–39	Coral, coralline.
4162	....do	21–24	Coral.
4163	....do	24–40	Do.
4164	....do	40–56	Coral sand, pebbles, shells.
4169	....do	21–22	Coral.
4170	....do	26–27	Coral sand, foraminifera.

I have compared the Hawaiian specimens with 2 full grown examples of *bradleyi* from the Gulf of California and a specimen of *clavigera* from the Fiji Islands. The latter, in the collection of the California Academy of Sciences, was taken by A. Garrett, and is labeled *Mithrodia spinulosa* Gray. This example is considerably different from any of the Hawaiian specimens. The rays are slenderer, meshes of the skeleton wider, the trabeculæ slenderer, and the granulation of the integument much finer. There is a median dorsal row of spines, which are widely placed beyond the middle of the ray and are few in number. The other spines are all relatively longer than in Hawaiian specimens, with the exception of the adambulacral armature. The trabeculæ have numerous small, spaced, tubercles which are not swollen and crowded as is often the case in the Hawaiian specimens. On the papular areas the granules are elongated into short spinelets of a rasp-like appearance. Furrow spinelets are 11, the central longest, and the 5 on either side graduated in length, the laterals being quite short. These are rather more delicate than in the Hawaiian examples, and decidedly more so than in those from the Gulf of California.

In *bradleyi* from the last locality the furrow spinelets range from 6 to 10, the central spinelets being slightly heavier and more clavate than in the Hawaiian examples. The number of spinelets is of not so great importance, since the Fiji example of *clavigera* has 11 (occasionally 10), while an example from Mauritius figured by P. de Loriol has but 8 and 9. There are no medio-radial spines in adult examples of *bradleyi* and all the spines appear shorter and stouter.

While the Hawaiian examples are not typical, they are certainly nearer *bradleyi* than *clavigera*. In the character of the furrow spinelets the specimens are nearly intermediate. Perrier in his Révision des Stellérides refers Hawaiian examples to *clavigera*, as noted in the synonymy, but later in the same work, under *Luidia brevispina*, says: "Si, comme j'ai quelques raisons de le croire les *Mithrodia* de Panama et des Sandwich sont spécifiquement identique, nous aurions donc deux especes d'Astéries communes à la côte occidentale d'Amérique et aux îles Sandwich" (p. 337). Evidently this authority had some doubts concerning the identity of the Hawaiian *Mithrodia*, and changed his mind after publishing the first part of his work.

To arrive at any satisfactory conclusions concerning the species of this interesting genus, one must have specimens from very many localities throughout its range, and preferably many specimens from each locality.

NOTES ON A PECULIAR SPECIMEN OF MITHRODIA.

Pl. XXXVII, figs. 2, 3.

There is one specimen in the collection which differs so widely from any of the others that it has not been included in the foregoing notes. R=140 to 145 mm.; r=33 to 37 mm. R=3.8 to 4.4 r. Disk rather large, rays stout, blunt, subcylindrical, heavy, not constricted at base, but on the contrary widening a little. Breadth of ray at base 35 to 40 mm. Interbrachial angles distinctly rounded. The ridges which are so conspicuous in the other specimens are scarcely perceptible in this, and are very much smaller and more numerous, dividing the body into irregular, very much smaller and more numerous papular areas. While in ordinary examples these trabeculæ are thrown into irregular and frequent prominences, in this specimen the whole surface of the body is covered with scattered, low, thimble-shaped tubercles. They arise abruptly from the inconspicuous trabeculæ, and are covered with small conical sharp granules very much larger than the tiny granules embedded in the rest of the integument. On the actinal surface there are 2 rows of these, larger than the rest, which correspond to the 2 actinal series in typical specimens, but the lateral row is entirely wanting. The spines of the innermost actinal series—that adjacent to the actinal armature of the adambulacral plates—are more numerous and larger than those of the outer row, which are almost wanting on one ray. The inner face of the actinal adambulacral spines is entirely covered with granules, is not naked as in typical specimens. There are 8 spinelets on the furrow series. Color in life, dull light cinnamon, pink and maroon at ends of arms. The cinnamon in places is mottled with buff. Actinal surface is light pinkish buff, or vinaceous, darkest on tubercles. Ambulacral feet raw sienna. The coloring is thus considerably different from the other specimens.

Young: There is a young example which seems to be near the above and which agrees with it very well in most particulars. The innermost actinal row of spines is very regular and straight, the spines themselves being shorter than those of the adambulacral series. There is also a second series of less numerous ventro-lateral, and a third series of lateral spines, all short, in addition to a few scattered on the dorsal surface. Actinal adambulacral spines and dorsal tubercles as in adult. R=38 mm.; r=12 mm.; breadth of ray at base, 14 mm.

Localities: Station 4147, Bird Island, 26 fathoms, coral and coralline; 4158, same locality, 20–30 fathoms.

Whether this is a different species from the common form, or only a freak, I am unable to state. If it is not a mere variation of *bradleyi*, it would apparently represent an undescribed species.

Family MYXASTERIDÆ Perrier, 1894.

Myxasteridæ Perrier, Expéditions Scientifiques du Travailleur et du Talisman, Echinodermes, 1894, p. 177.

Genus ASTHENACTIS, new.

Type *Asthenactis papyraceus*, new species.

Rays 7, long, flexible. Disk fairly large, capable of inflation. Actinostome very large and adambulacral furrows wide. Tube feet large, in 2 series, with sucking disks.

The whole abactinal and lateral surfaces of body are paved with very thin, delicate, papery plates, of a peculiar subcruciform or 4-lobed contour. They are immersed in thin, tough integument, and imbricate strongly, especially on sides of body, where they are arranged in fairly regular transverse rows. Individual plates are difficult to distinguish until the integument is dry. Each plate bears a sheathed tuft of spicules. Papulæ single.

Adambulacral plates are of curious shape, set somewhat obliquely, so that the outer aboral process of each plate fits against the outer side of the succeeding plate. Armature consists of an oblique transverse series of long, slender spinules divided between 2 adjacent plates. That portion of the comb nearest furrow is set on an oblique low ridge of one plate, and consists of 7 spinelets, while the outer part of series stands on the aboral extension of the adjacent adoral plate and consists of 3 spinelets, the entire 10 being united to their tips by a continuous web. The outermost spinelet of consecutive series is further united by a longitudinal ventro-lateral membrane which is perforated between each adambulacral series of spines.

Mouth plates are prominent actinally, of the *Myxaster* type, with a prominent beak aborally, and a marginal armature united by membrane.

Madreporic body large, not multiple.

This genus differs from *Myxaster* in the following important particulars: In the peculiar arrangement of the adambulacral plates and their spines, each transverse series of the latter, although united by membrane as in *Myxaster*, being common to 2 adjacent plates; by the presence of a sort of actino-lateral membrane uniting the successive adambulacral series, this membrane being perforated; abactinal and lateral plates are thinner and more delicate than in *Myxaster*, are immersed in membrane, and are not so regular along medio-radial region.

Asthenactis papyraceus, new species.

Pl. XL, figs. 3, 3a.

Rays 7. R=105 mm.; r=15 mm. R=7 r. Breadth of ray at base about 10–12 mm.

Rays long, and slender throughout, very flexible, tapering from a fairly narrow base to an attenuate extremity. They are subcylindrical, depressed near base. Margin of ambulacral furrow rounded. Disk fairly large and ambulacral furrows fairly wide. Ambulacral feet in 2 series, with prominent sucking disks. Integument like parchment, rather thin and papery, with numerous imbricating subcruciform plates.

Abactinal and lateral walls of body paved with very thin, delicate, papery plates of fair size, the 4 processes of each plate having rounded ends. Those at the sides of body are arranged in fairly regular transverse rows, and are rather closely imbricated. Here one can count about 4 or 5 plates to each transverse row. They imbricate in such a way that the upper edge of a plate overlies the lower edge of that just above. Their form and arrangement are perhaps best shown by the figure (pl. XL, fig. 3). Over abactinal area the plates may be described as stellate with 4 obtuse, often irregular lobes. They are not nearly so crowded as in the lateral walls, and do not appear to be regularly arranged, although they still imbricate by their lobes. Between these plates single small papulæ emerge. They are very inconspicuous, and are present also between some of the lateral plates. All plates are thin and of an embryonic character, and their outlines are difficult to discern. When prepared and examined under the microscope, they are seen to consist of an open calcareous meshwork of the most delicate description. Each plate bears a tuft or brush of long, delicate spicules, 4 or more to each group, the whole united by a delicate sheath. Spines of lateral plates are situated on the middle of upper border of plate. Surrounding the conspicuous anal opening, at a slight distance, is a circle of 7 tufts, radially situated, and larger than any of the others. The spinelets or spicules are very delicate in all these groups. Each has a deep longitudinal sulcus running its whole length, in the bottom of which are numerous perforations forming about 2 series. The disk is marked by a faint groove extending from each interbrachial angle to the periproct. The whole surface of the body is covered with a thin membrane which obscures the outlines of the plates. This is continued up over the groups of spines, forming the sheath mentioned above.

Ambulacral plates form a rounded margin to furrow, and are of unusual shape. Each is rounded on its exposed surface and sends a process aborally, external to the adjacent aboral plate. This process, which is wedged between the succeeding plate and the first row of actinal plates, is really only the exposed surface of a more extensive aboral end, overlaid by the adoral end of the succeeding plate. Its greatest peculiarity lies in the fact that it bears a group of spinelets which form a continuous series, not with the furrow spinelets of their own plate, but with those of the succeeding plate, to which they

stand just external. Armature, therefore, consists of 7 (becoming 6 at about middle of ray) long, slender spinules, united by a delicate web, forming a slightly curved, transverse, oblique series, placed on a tumid ridge on the rounded furrow margin, trending from the aboral furrow side outward and adorad. Inasmuch as the plates are set obliquely the series is not far off the transverse axis. This series is immediately continued on the aboral process of the adjacent adoral plate in 2 or 3 long slender spinules, also placed obliquely. The spines of the two series are united from base to tip by a single, continuous, delicate web. On the proximal portion of rays (the distal part being too injured to verify the structure there) the outer groups of spines of successive plates are united by a delicate longitudinal membrane, as shown in the figure (pl. XL, fig. 3a). This membrane is perforated between successive transverse series, and extends across interbrachial area just behind mouth plates, there being also a perforation at the outer end of combined dentary plates. The spines of inner or marginal series decrease in size toward aboral end of series, the last or inner spinelet being short (1 to 1.5 mm.). The longest spines are about 5 or 6 mm. in length. Outer series is subequal or slightly longer than longest inner spines.

Mouth plates prominent actinally, and triangular in shape, something like a plowshare. Each rises toward a perfectly straight, median suture to form a prominent keel. Edge of plate toward actinostome is broad, faintly convex, and produced just a trifle at the median suture. The outer end of the combined pair is also prolonged, so that it overhangs interbrachial area. Margin adjacent to furrow very short, concave, and high in furrow. Distal (adambulacral) margin concave, the suture slightly raised, so that a broad furrow is present between the first adambulacral and the smooth actinal face of plate. Armature consists of a series of 6 spines and spinelets on margin toward actinostome. The inner 3 or 4 are rather long, reaching nearly to outer end of plate, and are united by a web. The outer 2 or 3 are very short. On the short margin adjacent to furrow, near the shorter marginal spinelets, are 2 upright spinelets about the same length as the latter. The general surface of the plates is quite smooth, and the spines, as well as those of the adambulacral plates, are similar in structure to the abactinal spines already described, although much larger and stouter. They are nevertheless very delicate, and break almost at a touch.

Madreporic body large, convex, subcircular, very fragile, situated rather nearer center of disk than midway to margin. Striations are obscure and very irregular. Ambulacral plates are large, with very broad ends, the upper ends especially flaring. The apertures between the plates are large.

Color in life, dull pinkish ("salmon pink").

Locality: Station 4157, vicinity Bird Island, 762–1,000 fathoms, white mud, foraminifera, rocks; bottom temperature 38°. Type no. 21183, U. S. National Museum.

Family PTERASTERIDÆ Perrier, 1875.

Pterasteridæ Perrier, Révision de la Collection de Stellérides du Muséum d'Histoire Naturelle de Paris, 1875, p. 381.

Key to Hawaiian genera of Pterasteridæ.

a. Armature of adambulacral plates forming transverse combs, the spines being united by a web. Actinolateral spines forming a free, independent lateral fringe; not merged in the actinal floor; supradorsal membrane with muscular fibrous bands ..... PTERASTER

aa. Armature of adambulacral plates not forming transverse combs. Spines independent, not united by a web.

b. Nidamental cavity spacious. Supradorsal membrane well developed; spinelets of paxillæ not protruding through, but supporting the membrane ..... HYMENASTER

bb. Nidamental cavity small; supradorsal membrane exceedingly thin; muscle fibers absent or rudimentary. Spinelets of paxillæ fascicular, protruding a great portion of their length naked through the membrane. Size small ..... BENTHASTER

Genus PTERASTER Müller and Troschel.

Pteraster Müller and Troschel, System der Asteriden, 1842, p. 128. Type, *Asterias militaris* O. F. Müller.

Pteraster reticulatus, new species.

Pl. XXXVIII, figs. 5, 5a; pl. XXXIX, figs. 1, 2.

Marginal contour stellate. Interbrachial arcs angular. R=39 mm.; r=23 mm. R=1.7 r. Breadth of ray at base about equal to r. Disk not high. Abactinal surface rounded, sloping gradually to tip of ray. Sides of rays straight. Actinal surface sunken toward actinostome.

Supradorsal membrane thin but muscular; whole surface densely beset with the tips of paxillæ spinelets, which are very prominent though slender. Pedicels of paxillæ are rather longer than the spinelets, of which there are about 10 widely radiating to each group. There are apparently no spicules present in the membrane, which is marked off by a meshwork of muscular bands into polygonal or roundish areas. In the type these bands are not at all conspicuous; in fact, are rather indistinct, but in a specimen from station 3472 they are very well marked. In this specimen each area is slightly sunken, and is further broken up by the protruding tips of paxillæ spinelets, from which radiate numerous, much smaller, irregular fibers. On disk there are about a dozen large spiracula to each area, but on rays they are much less numerous. Oscular orifice large, but not conspicuous; surrounded by spines imbedded in membrane.

Ambulacral furrows narrow. Tube feet in 2 rows, with no tendency toward quadriserial arrangement. Armature of adambulacral plates consists of a transverse series of 6 or 7 spines. The innermost spinule is short and slender, about one-half the length of the next, and is placed a little aborad to the remainder of comb, which thus appears to curve slightly at furrow end. Each succeeding spine is considerably longer than the last, the outermost being about one-half the length of adjacent actinolateral spine, on the proximal portion of ray, but considerably more than one-half on distal portion. All radiate and are joined by a thin, semitransparent membrane, with shallow emarginations between the tips of the spines. The web, after passing the outermost spine, is joined to the actinolateral membrane (or the web of the actinolateral spines) somewhat aborad to that lateral spine corresponding to the plate. The adambulacral web of the first plate is confluent, just external to mouth plates, with web of first adambulacral of adjacent series. Segmental apertures are small. Aperture papillæ small, "jawbone-shaped," articulated by broader end, and free on aboral margin.

Mouth plates, with a broad, free margin. Marginal spines 6 or 7, the innermost tapering, exceeding the interradial dimension of plate in length, and reaching beyond center of actinostome. The next spine is shorter and much slenderer, while the remainder of series rapidly decreases both in length and caliber. The first 4 spines free, but membrane tipped; fifth and sixth usually united by a web. Irregularity exists in that it is occasionally the second and third, or the third and fourth, which are united by membrane. On actinal surface is a robust spine, slightly longer and much stouter than the largest marginal, tapering and pointed, sheathed in membrane, free, and directed outward away from actinostome. In a smaller specimen this spine is relatively larger, club-shaped, transparent, pinkish in color and crystalline in luster.

Actinolateral spines are very slender, rather long, the lateral fringe extending beyond the margin of test. Actinolateral membrane plane, wide.

Color in alcohol, faded pinkish gray to yellowish gray.

Localities: Type (no. 21184, U. S. National Museum) from station 3867, Pailolo Channel, between Maui and Molokai islands, 284–290 fathoms, fine sand and mud; bottom temperature, 43.8–44°; 2 specimens. Taken also by the *Albatross* in 1891, 3472, south coast of Oahu, 295 fathoms, fine white sand; 3476, same locality, 298 fathoms, same bottom; 1 specimen each haul.

This species is characterized by the reticulated supradorsal membrane, by the numerous and prominent spinules of the abactinal paxillæ, which give a very roughened appearance to the surface of the supradorsal membrane, and by the armature of the adambulacral plates and mouth plates. The spines of the mouth plates are not webbed, except 2 very small lateral marginals. The species appears to resemble most nearly *Pteraster semireticulatus* Sladen, from which it differs in the details of the adambulacral spinulation, the armature of the mouth plates, and to a less extent in the details of the dorsal surface.

Genus HYMENASTER Wyville Thomson.

Hymenaster Wyville Thomson, The Depths of the Sea, London, 1873, p. 120. Type, *Hymenaster pellucidus* Wyville Thomson.

Hymenaster pentagonalis, new species.

Pl. XXXVIII, figs. 6, 6a-b; pl. XL, fig. 2; pl. XLI, fig. 1.

Marginal contour nearly pentagonal. No interbrachial arcs in perfect specimen, the sides being fairly straight. R=80 mm.; r=60 mm. R=1.33 r. Abactinal area nearly flat, or probably in life slightly convex when the tissues are fully expanded. Actinal area plane. Margin rather thick and fleshy, irregularly scalloped (probably due to unequal shrinkage).

Supradorsal membrane thick, soft, fleshy, and nearly opaque in alcohol. It is irregularly wrinkled, very probably due to shrinkage in alcohol, and in consistency resembles the bell of a tough jellyfish. Scattered rather widely along the radial areas are a number of prominent, soft, pointed papillæ. In the type these are almost wanting, or are at least very short, but in 2 other specimens, which undoubtedly belong to this species, they attain the length of about 8 mm. Their size depends somewhat upon the degree of contraction of the dorsal membrane surrounding them. There are about 30 to 40 to each radius, in the specimen on which they are best developed, and 2 or 3 stand in the interradius near the oscular valves. Each has a very slender paxilla spinelet running its whole length. From the outside these paxilla spinelets are scarcely perceptible, as they are exceedingly delicate. If the actinolateral membrane is carefully removed they may be seen springing from the very rudimentary abactinal membrane or true body wall. Each paxilla consists of a slender, cylindrical, basal portion, the summit of which is slightly enlarged to afford articulation for 4 extremely delicate, long, bristle-like spinelets united by membrane, which enter the supradorsal membrane and radiate widely apart, imbedded in the tissue. Occasionally there are 5 in the larger fascicles on the lateral and proximal portions of the radial areas. It is one of these slender spinelets which is imbedded in the papilla and extends to its tip. Not all the paxillar fascicles have papillæ corresponding to them. The paxillæ are well-spaced and extend in 2 irregular series along each side of the median radial line, those of the outer series being largest. All diminish in size toward extremity of area. No specialized bands of muscle in the supradorsal membrane. Spiracula microscopic, very inconspicuous and impossible to detect without strong magnification; confined to small, elongated, irregular, or substellate groups, of 25 or even more, which are widely scattered among the papillæ. Oscular orifice large. Valves broad, nearly truncate, fan-shaped, all united by a web. Spines slender, numerous (18–19), about 10 or 11 mm. long, springing from a fan-shaped, triangular basal piece, with a curved margin (about 6 mm. wide) for the attachment of spines.

Ambulacral furrow wide (8–12 mm.), narrowing abruptly toward extremity; shallow. Armature consists of 2 slender, tapering, sharp spinules close together in a longitudinal, often a trifle oblique series, on tumid furrow margin. Adoral spinule is slightly the longer, although near base of ray it may be shorter. Both are sheathed in membrane, which is not evident except at tip, where there is a sort of fleshy thickening, extending slightly beyond extremity. Distal plates of series (usually beyond middle) have only 1 spine. Rarely a few scattered plates in proximal portion of series have but 1, also, and the first plate usually 3. Segmental apertures small; aperture papilla (the spinule standing directly in front of each aperture and acting as a valve to close it) of fairly large size, rather broadly suboval, invested with a pulpy membrane. Aperture papilla of the first adambulacral plate is multifid, and is immersed in the actinolateral membrane, for which it acts as a sort of support, immediately behind the combined mouth plates.

Mouth plates large and broad, with a prominent keel at the interradial junction of the plates. The outer end of the combined pair is most prominent, forming a sharp point which projects upward when the specimen is laid on its back. The inner end also forms a beak pointed toward the actinostome. Armature consists of a marginal series of 5 sharp, slender spinules on the lateral flange. Rarely a sixth spinule is added adjacent to the first adambulacral. A membrane-invested spinelet similar to and homologous with the aperture papillæ stands just external to the innermost of the marginal spinelets. Rarely an acicular spinelet stands on the general surface of the lateral flange.

Actinolateral spines long, slender, and rather closely placed, about 40 to 50 in number. Actinolateral membrane translucent.

Madreporic body, as seen through the dorsal osculum, is large and very convex.

Color in life, light rose pink.

Localities: Type (no. 21185, U. S. National Museum) from station 4090, northeast approach to Pailolo Channel, between Maui and Molokai islands, 304–308 fathoms, fine gray sand; bottom temp. 43.8°. Taken also at 3911, south coast of Oahu, 337–334 fathoms, fine gray sand and mud; 3914, 289–292 fathoms, gray sand and mud, same locality (6 specimens).

This species is characterized by the shape of the disk, the generally fleshy character of the supradorsal integument, by the miscroscopic spiracula, and by the armature of the adambulacral and mouth plates. It most nearly resembles *Hymenaster curiosus* Sladen, from off the west coast of South America (1,500 fathoms), from which it differs in the number and distribution of spiracula, character of abactinal surface, shape of disk, armature of adambulacral and mouth plates, and probably also in having weaker paxillæ spinelets.

Genus BENTHASTER Sladen.

Benthaster Sladen, Journ. Linn. Soc. London (Zool.), vol. XVI, 1882, p. 242. Type *Benthaster wyville-thomsoni* Sladen.

Benthaster eritimus, new species.

Pl. XXXVIII, fig. 7; pl. XL, figs. 1, 1a–b.

Marginal contour substellate, interbrachial arcs wide, angular, and only moderately indented. R=10.5 mm.; r=6 mm. R=1.75 r. Rays taper gradually from a broad base, tips upturned. Abactinal surface slightly convex, rather depressed. Actinal surface slightly convex.

Supradorsal membrane is very delicate, transparent, appearing scarcely more than a film. It is, however, remarkably resistant, and when examined under the microscope by transmitted, or even reflected light, small muscle fibers can be distinguished meandering through the membrane, forming an illy defined net work. There are, besides, small spiracula (?) scattered here and there. Each appears to be surrounded by a thickening of the membrane, making the aperture well defined when the membrane is examined by transmitted light. But on account of the small size of the animal, these spiracula are quite microscopic, and are impossible to distinguish except in a strong light. It is barely possible that they are apertures through which the spines of the paxillæ protrude (the spines having been broken), but this is in no wise probable from their numbers and position. There is not more than 1 to an indefinite mesh of the muscular reticulum, but they do not occur in all the meshes. The membrane can scarcely be called spongiform, the term used by Sladen in describing *B. wyville-thomsoni* and *B. penicillatus*, for it is thin and of uniform thickness throughout. Paxillæ are fairly numerous and are well spaced. Pedicels are long (for genus), slender, and delicate, springing from delicate cruciform plates with long processes. Pedicels on disk (1.75 mm. long) are about one-half the length of spinelets. The latter are relatively long, delicate, glassy, about 8 to 10 to each paxilla of disk, and about 5 on outer part of ray. They are swollen slightly at base for articulation to tip of pedicel, radiate slightly apart, and protrude for the greater part of their length beyond the supradorsal membrane. Each spinelet appears to be perforated along its entire length by minute holes, and to be made up of 3 rods coalesced, so that a cross-section would appear trilobate.

Cruciform plates, from which the pedicels spring, have remarkably long, slender processes, which are usually unequal. There is no tendency for them to become rotund or squamiform. Oscular orifice is large. The "valves" are large, radial in position, the pedicel much enlarged, and expanded at the top as in *Hymenaster*. A muscle band joins the crests of the pedicels as a sort of sphincter. Spinelets many, arranged on the expanded top of the valve pedicel in about 3 series. Papulæ are large, full, bilobate or trilobate, pulpy sacs, constricted at the base, few in number, and are situated on either side of the ray near the base. Just external to one of the valve ossicles is the small, inconspicuous, madreporic body. Anal opening prominent.

The "superomarginal" plates are reduced to 2, which form an arch over the terminal tentacle and are armed with a tuft of numerous spinelets. They appear to be smaller, or at least to extend not so far orad as in the other 2 species.

Adambulacral furrows are wide. Tube feet large, in 2 series. Armature of adambulacral plates consists of a series of 5, long, slender spinelets, which are invested by an exceedingly delicate membrane. They are placed along the furrow margin, often somewhat obliquely on account of the obliquity of the plate itself. The longest spinelets reach across the furrow. They decrease in length toward the aboral end of the series, the outermost being much shorter than the other 4, which are not greatly different in length. Segmental apertures are apparently absent, but a flattened, short, lanceolate-acuminate spinelet, devoid of any perceptible membrane, stands on the actinal surface of the plate, and is bent outward over the actinolateral membrane. This spinelet is enlarged on the first adambulacral plate, is flat, thin, and irregularly multifid. It is lodged in the actinolateral membrane just external to the mouth plates, and seems to serve as a support for the membrane.

The mouth plates are of the *Hymenaster* type. They are prominent actinally and aborally. Armature as follows: (1) 2 slender spinelets on actinal surface of plate near median suture, the outer slightly farther from the suture than the inner. (2) On the margin near the suture, 2 slender spinelets, the outer of which is about one-half the length of the inner, which stands in a linear series with, and is exactly similar to the innermost actinal spinelet. Two much smaller spinelets stand on a slight lateral flange of the plate and are usually directed into the mouth of the ambulacral furrow. All the spinelets are tapering and sharp, and the larger, at least, are encased in a delicate membrane which is only evident at the tip.

Actinolateral spines rather widely spaced, the fifth or sixth from the mouth plates being longest. They extend beyond edge of body, and there are 18 to each side of a ray. Actinolateral membrane transparent, finely and irregularly marked by fibers, much after the manner of the supradorsal membrane. There is a lateral fringe, which extends a short distance beyond the margin of the body.

Color in alcohol, translucent yellowish gray.

Locality: Station 3824, south coast of Molokai Island, 222–498 fathoms, coral, broken shells; bottom temperature, 49.5°; 1 specimen, type no. 21186, U. S. National Museum.

Benthaster is an exceedingly rare type, the other 2 species having been dredged by the *Challenger*. *Benthaster wyville-thomsoni* was taken in 2,900 fathoms in the mid-north Pacific, between Yokohama and San Francisco, near the meridian 170° E., from red clay. *B. penicillatus* came from off the north coast of New Guinea, southwest of the Admiralty Islands, 1,070 fathoms, blue mud. It is somewhat remarkable, therefore, that the present form should have come from not nearly so great a depth.

Benthaster eritimus differs in several respects from the 2 other members of the genus. In the first place the nidamental cavity is more spacious, and better developed, as the pedicels of the dorsal paxillæ are rather long, and thus support the supradorsal membrane well above the true abactinal wall of the body. The membrane appears to be plentifully supplied with muscle fibers, which form a sort of reticulum, although they are rather simple in structure. Spiracula are present, especially over the region of the bilobate or trilobate, fleshy "papulæ". These spiracula are said to be absent in the 2 other species. The spinelets of paxillæ are rather fewer in number. Adambulacral armature consists of 5 furrow spines and an aperture papilla. Lateral fringe is present. Marginal plates are much reduced and are confined to the extreme tip of the ray.

Order FORCIPULATA Perrier.

Family ZOROASTERIDÆ Sladen, 1889.

Zoroasteridæ Sladen, Report on the Asteroidea collected during the Voyage of H. M. S. *Challenger*, etc., Zool., vol. xxx, 1889, p. 416.

Genus ZOROASTER Wyville Thomson.

Zoroaster Wyville Thomson, The Depths of the Sea, 1873, p. 154. Type *Zoroaster fulgens* Thomson.

Zoroaster spinulosus, new species.

Pl. xxiv, fig. 3; pl. xli, fig. 2; pl. xlii, figs. 5, 6.

Rays 5. R=118 mm.; r=11 mm. R=10.7 r. Breadth of ray at base, 12 mm. R=10.6 r to 14.3 r.

Rays very long and slender, subcylindrical, tapering gradually to a prolonged, finely pointed extremity. Abactinal surface arched, with very evident lateral faces to rays. Edges of furrow tumid. Disk small, slightly tumid, center rather higher than the median ridge of rays. Interbrachial angles extremely acute.

The calcareous skeleton of whole test is composed of roughly diamond-shaped or slightly lobed hexagonal plates, all with rounded corners, arranged in perfectly regular longitudinal and transverse rows. Median radial series is composed of the largest plates of ray, while those of the disk are largest of all. Their arrangement (which is to be regarded as of generic rather than specific importance) is as follows: Surrounding a scalloped, dorsocentral plate are 5 radially situated infrabasals of about the same size. An odd plate may be present between 1 or 2 pairs of these. Outside of infrabasals are the interradially placed, much larger, oblong basals, one of which has the madreporic body at its outer edge. Outside of and alternating with these are 5 primary radials about the same size as the basals. Proceeding outward from each primary radial, along the median line of ray, is a regular longitudinal series of plates, tumid or tuberculated, hexagonal in general form, but with each edge of the hexagon, especially that on either side, indented, giving a shield-shaped appearance. On each side of the radial series is a parallel adradial row of smaller plates which is succeeded by another parallel, somewhat larger series of plates, slightly tumid, and forming a faint ridge at junction of lateral and abactinal faces of ray. The edges of these plates and those of the radial series overlie the adradials. Between this marginal series and the adambulacral plates are 5 additional, perfectly regular, longitudinal series, the plates of which likewise form regular transverse series with the marginals, there being thus 6 plates to each transverse series beyond the adradials. The lower end of the plates of each lateral series,

including the marginal, overlies the upper end of those of the next series below, while the aboral edge of each plate underlies the adoral edge of the succeeding plate in a longitudinal series. At base of ray most of the lateral series are confined to side of ray, only the lowermost taking any part in the actinal surface, but toward the middle of the ray the latter series gradually diminishes in size and ends, and the second series is adjacent to the adambulacrals. In outer third of ray second series dies out, so that then only 3 series intervene between the marginals and adambulacrals. All of the plates are very slightly convex, and the 2 lowermost series are slightly smaller than the 3 upper, all of which are a trifle smaller than the (supero-) marginal series. Papulæ are in regular rows between successive series of plates, single, except near base of ray, where there may be 2 or 3 to a pore. Surface of all plates is covered with numerous, delicate, short, papilliform, spinelets, each invested by a thin membraneous sheath, which is frequently swollen to resemble a slender miniature barley-grain. These spinelets are articulated to granular protuberances on the surface of plates, and, though numerous, are distinctly spaced. They form a rather coarse nap all over the surface. The medioradial plates are submammilated, and surmounted by a short, stumpy, conical spine. In extreme cases there is a definite carinate ridge along the medioradial line, each plate being surmounted by 1 to 3 short, cylindrical, blunt spines or tubercles. Superomarginal plates are not prominently mammilated as in the *Z. diomedæ* type. In neighborhood of papulæ are small, very inconspicuous, forficiform pedicellariæ scattered among the spinelets. They are larger and more numerous at base of rays and on disk.

The superomarginals, and plates of all intermediate series between them and adambulacrals, each bear a delicate central spinule much longer than the surrounding miliary spinelets. These spinelets dimish in size toward adambulacral furrow. They are usually bent upward, appressed to side of ray, and are articulated to a granular boss on the plate, being surrounded by a number of miliary spinelets and several small pedicellariæ.

Each alternate adambulacral plate is developed into a prominent ridge, which extends into furrow, and separates neighboring tube-feet. The other plates do not have such a ridge. Armature consists of 4 rather long, cylindrical, tapering spines, 2 directed into furrow and 2 standing on actinal surface. On distal half of ray the outer spine is much reduced or wanting. The series is disposed in single file along the ridge, and the innermost spinule is rather the most delicate. This is usually directed obliquely and adorally toward center of furrow, and bears at its tip a curious membranous expansion, sometimes subcircular in outline, around the periphery of which are arranged 5 to 8 small forficiform pedicellariæ, usually graduated in size. These frequently extend down the side of the spinule, the largest pedicellariæ being nearest the tip. The second spine is also directed toward center of furrow, but aborally, and bears on its basal portion a giant forficiform pedicellaria, often considerably longer than spine itself. Occasionally 2 pedicellariæ are borne on the second spine, in which case both are smaller than when there is only one. Again, the third spine has a pedicellaria, but this is not usually the case. On the outer part of each plate 1 or 2 miliary spinelets and a pedicellaria are usually present. This extra spinelet is always much shorter than the 2 actinal spines. The intermediate adambulacral plates bear a mobile, tapering spine on the edge of furrow, about equal in length to the third spine of prominent plates. External to this is a much smaller spinule, which stands in a longitudinal series with outer spinelets of prominent plates, and near its base is a small pedicellaria. Well within the furrow is a small spinelet, just abactinad from the larger, which, except at base of ray, usually bears 1 or 2 small pedicellariæ. Occasionally the place of this spinelet may be taken by a single pedicellaria.

Actinostome is deeply depressed, the mouth plates being entirely within the cavity. Their armature consists of 3 or 4 robust, slender, slightly flattened spines at each angle. The innermost pedicellariæ are very prominent.

Madreporic body small, with few irregular coarse striations; situated just outside a large interradial (basal) plate. Anal opening small, situated just to left of dorsocentral plate. The tube-feet form 4 close-set rows at base of ray; less obviously 4 on distal half. A prominent plate of one side of the furrow is opposite an intermediate of the opposite.

Variations: The most important variation from the type is that of a full-grown specimen which has regularly 5 spines on the prominent adambulacral plates, the third in addition to the second carrying a large pedicellaria. A small spinule in the type forms a fifth member to the series, but only rarely does a pedicellaria occur on the third or inner actinal spine. Another specimen has a very prominent median radial series of mammilated plates, each of which is surrounded by 1 to 3 stumpy spinelets. In this specimen the superomarginal plates are slightly more prominent than is usual, but

each bears a slender spinule, as in the type. The principal dimensions of the 5 specimens are as follows:

Measurements of specimens of Zoroaster spinulosus.

Station.	Radius.	Minor radius.	Width of arm at base.	Proportion of r to R.
	mm.	*mm.*	*mm.*	
3892	117	11	12	1:10.7
4007a	122	9	10	1:13.5
4007b	90	8.5	10	1:10.6
4112	150	10.5	12	1:14.3
4139	118	8.5	10	1:13.8

Color in life: Abactinal surface buff; actinal surface orange buff to orange within furrow.

Localities: Type (no. 21187, U. S. National Museum) from station 3892, north coast of Molokai Island, 328–414 fathoms, fine gray sand; bottom temperature, 42.5°. Taken also at 4007, south coast of Kauai Island, 508–557 fathoms, gray sand and foraminifera; 4112, Kaiwi Channel, between Molokai and Oahu islands, 447–433 fathoms, fine sand; 4139, southwest coast of Kauai, 512–339 fathoms, gray sand and rocks; 5 specimens in all.

The rays of this form are much slenderer than in the *Z. diomedæ* group and also longer. The species is particularly characterized by the armature of the adambulacral plates, by the absence of tubercles from the superomarginals, by the presence of 1 slender spinule on each of the superomarginals and on each plate between the latter and the adambulacral series. There are besides numerous pedicellariæ on the general surface of the body, particularly in the neighborhood of the papular pores.

Family HELIASTERIDÆ Viguier, 1878.

Heliasteridæ Viguier, Anatomie du Squelette des Stellérides. <Arch. Zool. Expér. et Génér. t. VII, 1878, p. 111.

Genus HELIASTER Gray.

Heliaster Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 179. Type *Asterias helianthus* Lamarck.

Heliaster multiradiata (Gray).

Asterias (*Heliaster*) *multiradiata* Gray, Ann. N. H., ser. 1, vol. VI, 1840, p. 180.

This species is reported from the Hawaiian Islands (Sladen, Challenger Asteroidea, p. 556), but was not secured by the *Albatross* expedition. I seriously doubt the validity of this record, as the habits of the species are such that it would not easily escape detection.

Family ASTERIIDÆ Gray, 1840, emend.

Asteriidæ Gray, Synopsis of the Genera and Species of the Class Hypostoma (*Asterias* Linnæus). <Ann. N. H., ser. 1, vol. VI, 1840, p, 178.

Key to Hawaiian species of Asteriidæ.

a. Abactinal spines arranged in 3 definite longitudinal series, large and isolated, bearing thick wreaths of pedicellariæ. Armature of adambulacral plates consisting of 2 spines.
Coscinasterias (*Distolasterias*) *euplecta*

aa. Abactinal plating forming a quadrate meshwork. The plates numerous, small, and imbricating by their 4 lobes, leaving open spaces through which protrude the single papulæ. Each plate bears 1 to 3 small spinelets of uniform size and several crossed pedicellariæ. Armature of adambulacral plates consisting of either 1 or 2 spines.....*Hydrasterias verrilli*

Genus COSCINASTERIAS Verrill.

Coscinasterias Verrill, Trans. Conn. Acad. vol. I, pt. 2, 1869, p. 249. Type, *C. muricata* = *Asterias calamaria* Gray.
Stolasterias Sladen, Challenger Asteroidea, 1889, pp. 563, 583 (subgenus).

The genus is here used not in the very restricted sense of Perrier (Exped. Travailleur et Talisman. Echinod. 1894, p. 108), but as equivalent to the subgenus *Stolasterias* of Sladen (Challenger Asteroidea, 1889, pp. 563, 583). It thus includes—besides *calamaria—tenuispina, gemmifera, volsellata, stichantha, custyla, glacialis*, and other similar forms.

Stolasterias Sladen (type *Asterias tenuispina* Lamarck) is antedated by *Coscinasterias* Verrill (type *Asterias calamaria* Gray), and hence becomes a synonym of *Coscinasterias* as used in this broader sense.

In 1894 Perrier (op. cit.) divided this group into 3 genera: *Coscinasterias* Verrill (type, *calamaria*), *Polyasterias* Perrier (type, by inference, *tenuispina*), *Stolasterias* Sladen, emended (type, *glacialis!*). In 1896[a] he added another genus, *Distolasterias* (type, *stichantha* Sladen), for the 5- or 6-rayed species, with 2 adambulacral spines to a plate. Since *Asterias tenuispina* had already been made the type of a subgenus, *Polyasterias* is a synonym pure and simple of *Stolasterias* Sladen (s. s.); while *glacialis*, having served as the type of *Marthasterias*[b] Jullien, does not need another name. This renaming of previously named genera has unnecessarily confused this group of species. Whether we have merely a subgenus of *Asterias*, a genus, or four genera is a matter of opinion. In this paper I have taken the middle course, and have regarded Perrier's genera as subgenera of *Coscinasterias*. They will, in this relation, stand as follows:

Genus *Coscinasterias* Verrill, 1869.

Subgenus *Coscinasterias* Verrill, 1869; type, *Asterias calamaria* Gray.

Subgenus *Stolasterias* Sladen 1889, restricted; type, *Asterias tenuispina* Lamarck (= *Polyasterias* of Perrier).

Subgenus *Marthasterias* Jullien, 1878; type, *Asterias glacialis* O. F. Müller, subnomine *M. foliacea* (= *Stolasterias* Perrier nec Sladen).

Subgenus *Distolasterias* Perrier, 1896; type *Asterias* (*Stolasterias*) *stichantha* Sladen.

Subgenus DISTOLASTERIAS Perrier.

Distolasterias Perrier, Rés. Campag. Sci. du Prince du Monaco, fasc. XI, 1896, p. 34.

Coscinasterias (Distolasterias) euplecta, new species.

Pl. XLI, figs. 4, 4a–c; Pl. XLII, figs. 1–4.

Rays 5. R = 88 mm.; r = 10 mm. R = 8.8 r. Breadth of largest ray at base, 13 mm. Height of ray near base, 14–15 mm.

Rays robust, fairly elongate, tapering to a bluntly pointed extremity; higher than broad, at least in proximal two-thirds. In section each ray would be pentagonal, the broadest face being the actinal. Sides between ventrolateral and superomarginal spines perpendicular. Either side of the abactinal surface slopes upward toward the median radial series of spines. Disk small, lower than the median radial line of rays. Rays appear constricted at base, and are further marked off from the disk by a sort of transverse sulcus. Abactinal surface of disk convex. Interbrachial arcs very acute.

The abactinal surface of rays is bounded on either side by a dorsal marginal series of plates, either lateral sloping face of the abactinal area being of greater width than the perpendicular sides of the ray. Every alternate plate of the superomarginal series bears a single robust, rigid, sharp, conical, fairly slender spine, 3 to 4 mm. in length, which is encircled at the base with a prominent cushion or wreath of closely packed pedicellariæ covered with membrane. The median abactinal line of the ray is occupied by a precisely similar longitudinal series of subequal spinules which decrease gradually in length toward the tip of the ray, and are also surrounded at the base by a wreath of pedicellariæ. On the outer part of the ray the wreaths touch in alcoholic specimens, but on the proximal half they are always separated by about 2 mm. In the interval between the median radial and superomarginal series of spinelets there may be from 1 to 7 widely separated, exactly similar but smaller spinules, each with a basal wreath, disposed in a longitudinal series. On one large ray there are none whatever. Papulæ large, sac-like, delicate. They extend in a longitudinal series of groups (3 or 4 to 8 in each group) on either side of the median radial series of spines, with another similar series just above each superomarginal row of spines. A very irregular series occurs scattered between these two, but there are but 2 series of papular "pores" to either side of the abactinal area. There is a central spinule on the disk, 2 radial spinules near base of ray, and 1 interradial spinule. There are also 5 irregular groups of papulæ between the central and basal plates, and among them are a number of large forficiform pedicellariæ. The lateral, perpendicular face of the ray is occupied by a series of papulæ in groups of 4 to 6. The general surface of the rays and disk is covered with a thin pulpy and slick but tough membrane, marked by numerous irregular, crosswise anastomosing lines of darker color, which appear to be very small furrows, possibly sensory in function.

[a] Contrib. à l'Étude des Stellérides de l'Atlantique Nord. < Rés. Campag. Sci. du Prince du Monaco, fasc. XI, 1896, p. 34.

[b] *Marthasterias foliacea* Jullien, Bull. Soc. Zool. France, 1878, p. 141. Equivalent to *Asterias glacialis*, according to Sladen and Ludwig.

The rather crowded inferomarginal plates form the border of the plane actinal surface. Each plate bears 2 spines in a diagonal, crosswise series, the outer spine usually the longer. Both are flattened, chisel-shaped, and radiate slightly apart. The outer is as long or a trifle longer than the superomarginal spines, and bears, on the outer side of base, a thick, subglobular cushion of pedicellariæ, which do not in this case form a wreath. Each plate bears also 1 or 2 fairly large, forficiform pedicellariæ at the base of the spines; the inferomarginal plates form a ventrolateral carination to the ray which extends further ventrad than the adambulacral plates. In a sort of shallow groove between the 2 is a longitudinal series of large, solitary, bag-like pedicellariæ. In the actinal interradial furrow there are 8 to 10 large forficiform pedicellariæ.

Adambulacral plates are small and crowded. Armature consists of 2 equal, flattened, very slightly tapering, obtusely tipped spinules nearly as long as the inferomarginal spines but much slenderer. The tip is often truncate. Ambulacral furrow crowded with quadriserially arranged tube feet.

Madreporic body large, 3 mm. in diameter, subcircular, situated near margin. Striations fine, radiating.

Color in life, rather pale Naples yellow, the arms broadly barred, and the disk mottled, with rich brown madder. A very young specimen is Naples yellow, cadmium at tips of arms.

Young: Small specimens (R=6 to 23 mm.) which I have considered the young of this species differ considerably from the adult in general appearance. The rays are not so high, and the abactinal and superomarginal spines are reduced to tubercles on the plates. An intermediate series of abactinal tubercles extends about one-third the length of the ray. The pedicellariæ are few in number and are scattered over the abactinal and lateral surfaces. The papulæ are still single. On the disk there is a pentagonal series of tubercles, the primary radials being largest. Inside this apical area are numerous other thimble-shaped tubercles or spinelets. Inferomarginal spines 2, as in adult. Some specimens with regenerating arms are 6-rayed.

Localities: Type (no. 21188, U. S. National Museum) from station 3885, adult and young, Pailolo channel, between Maui and Molokai islands, 136–148 fathoms, sand and pebbles; bottom temperature 64.8°. Taken also at the following stations:

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3885	South coast of Molokai Island	169–182	Fine brown sand, mud.
3859	Pailolo channel	138–140	Fine sand and mud.
4045	West coast of Hawaii Island	198–147	Coral sand, foraminifera.
4062	Northeast coast of Hawaii Island	83–113	Coral, volcanic sand, shells.
4064	do	63–107	Do.
4056	Aleunihana channel, between Hawaii and Maui islands	176–49	Rocky.
4079	North coast of Maui Island	143–178	Gray sand, foraminifera.
4100	Pailolo channel	130–151	Coral sand, shells, foraminifera.
4101	do	143–122	Do.

All these specimens, 31 in number, are immature except those from station 4062.

This species is most nearly related to *Stolasterias eustyla* Sladen from the Tristran da Cunha Group, 100–150 fathoms, from which it differs in having 2 instead of 3 inferomarginal spines, stouter and longer adambulacral spines, and a very much less developed intermediate row of spinules between the superomarginal and medio-radial series. Mr. Sladen states in his description of *eustyla* (Challenger Asteroidea, p. 587) that each superomarginal and, by implication, each carinal plate bears a spine. In the present species it is each alternate plate.

Genus HYDRASTERIAS Sladen.

Hydrasterias (subgenus of *Asterias*) Sladen, Challenger Asteroidea, 1889, pp. 563, 581. Type *Asterias* (*Hydrasterias*) *ophidion* Sladen. *Hydrasterias* Perrier, Exped. Scientif. du Travailleur et du Talisman, Echinodermes, 1894, p. 109.

Hydrasterias verrilli, new species.

Rays 5. R=85 mm.; r=11 mm. R=7.7 r. Breadth of ray at base, 13 mm.; greatest breadth, a little beyond the base 16.5 mm.; breadth about midway between base and extremity, 10 mm.

Rays elongate, rather narrow, inflated near base, thence tapering to the pointed extremity; depressed near base but distally subcylindrical. Interbrachial arcs very acute, the series of adjacent

rays being there pressed together. Disk not elevated above actinal surface of arms, from which it is marked off by a slight constriction.

The abactinal plates are not very regular as to shape, but may be said to be cruciform with short rounded processes, by the tips of which adjacent plates imbricate. The median radial series is most regular, and can be easily distinguished. The other abactinal plates are often rather irregular, and small intermediate ossicles may be interpolated to complete the close mesh work, which forms roundish or irregular papular areas, rather smaller than the plates, and containing each 1 or 2 papulæ. The plates themselves are convex and each bears 1 (less commonly 2 or 3) short, stout, subclavate, bluntly pointed spinelet. The spinulation of the disk and rays is the same. In addition, each plate bears 1–3 spaced, small, broad-tipped, crossed pedicellariæ (see pl. XLI, fig. 3b). The jaws when viewed from the broad side are quite spatulate, and broader than is usual in this type of pedicellariæ. Sometimes the pedicellariæ appear to be attached to the membrane of the papular area.

Immediately external to the adambulacral plates is a series of much larger, convex, subcordiform plates, possibly representing the inferomarginals. Each of these bears, in a transverse slightly oblique series, 2 blunt, robust, tapering, often slightly curved spines, much larger than any of the abactinal or lateral spinelets, and rather more robust, though not longer, than the adambulacral spines. Occasionally only one spine is present. At the base of the ray a few plates have an accompanying forficiform pedicellaria, 4 or 5 times as large as the ordinary forficiform variety, and with rounded denticulate tips to the jaws. The superomarginal plates are strongly cruciform, the longest axis being transverse and somewhat oblique. In addition to the usual spaced pedicellariæ each plate bears a single spinelet, identical in shape, but sometimes a trifle larger than those of the abactinal plates. The whole test is overlaid with a thin skin which invests plates, spines, and pedicellariæ. The spinelets are quite easily broken off. In alcoholic specimens they are movable. In general both spines and pedicellariæ appear numerous.

The adambulacral plates are small, short, and band-like, and each bears a cylindrical, untapered, often subclavate, blunt spinelet. Relatively few of the plates have 2 subequal spinelets, but 1 is the rule. Usually the spinelets are a trifle curved, and some have a curious elbow at the base. Like the rest of the test the adambulacral plates and spinelets are invested with thin membrane. Each mouth plate has a large forficiform pedicellaria on the actinostomal border adjacent to the enlarged, clavate, pointed mouth spine. Actinostome small, closed by the two mouth spines of each angle.

Madreporic body small, convex, situated nearer margin than center. Striations are in the form of curved or irregular slits, not continuous lines. Along adcentral border of the body are 6 or 7 spines, belonging to the adjacent (basal?) plate.

Locality: Station 3867, Pailolo Channel, between Molokai and Maui islands, 284 to 290 fathoms, fine sand and mud; bottom temperature, 44°; 1 specimen, type no. 21189, U. S. National Museum.

This is a very distinct, and in one respect, aberrant species of *Hydrasterias*. Both *H. ophidion* and *H. richardi* are diplacanthid, but *H. verrilli* usually has only 1 spine to each adambulacral plate. In general form the present species resembles *ophidion* more than *richardi* (which is probably immature). *Verrilli* differs from *ophidion* in the following respects: *Verrilli* has usually but 1 terete, untapered, adambulacral spine, *ophidion* 2, tapered; *verrilli* has no small forficiform pedicellariæ on the furrow margin, *ophidion* has; *verrilli* has 2 relatively large inferomarginal spines, *ophidion* 1 small one; *verrilli* has a number of large proximal inferomarginal forficiform pedicellariæ, together with 1 large one on each mouth plate, *ophidion* lacks these. Other differences exist in the form of the abactinal plates, spines, and pedicellariæ, as well as in the relative size of the spines of the disk and rays. The madreporic bodies also are different. *Verrilli* is not especially closely related to *richardi*, from which it differs considerably in general form and in details of armature.

This species is named for Prof. A. E. Verrill, of Yale University.

Family BRISINGIDÆ G. O. Sars, 1875.

Brisingidæ, G. O. Sars, On some Remarkable Forms of Animal Life from the Great Deeps off the Norwegian Coast, II.—Researches on the Structure and Affinity of the Genus Brisinga, 1875, p. 101.

Key to Hawaiian genera of Brisingidæ.

a. Abactinal membrane of disk and basal portion of arms punctured by conspicuous papulæ....ODINIA
aa. No papulæ present.....BRISINGA

Genus ODINIA Perrier.

Odinia Perrier, Ann. Sci. Nat. (Zool.), t. XIX, 1885, p. 9.

Odinia pacifica, new species.

Pl. XLIII, fig. 1; pl. XLVII, figs. 1, 1a–d.

Rays 17. R = 240 mm.; r = 13.5 mm. R = 17.7 r, approximately. Breadth of ray at base, 7 mm.; at widest part of genital expansion, from 8 to 16 mm.; midway along ray, about 6 mm. Rays united at base, by marginal plates, for a distance of 7 to 8 mm. from margin of disk.

Rays elongate, slender, fairly narrow at base; often swollen considerably just beyond the base into a prominent ovarial inflation, the tumidity of which is greatest abactinally. In some cases the swelling is nearly absent, but in others it is very prominent, resembling a big gall. The latter is probably artificial, having been produced when the creature was thrust into alcohol. Beyond this portion the ray is very slender and gradually tapering, the ambulacral ridge being clearly visible through the thin abactinal membrane. Ray is roughly equilaterally triangular in section, the corners, of course, being well rounded.

Disk of fair size, circular, with rather high sides, so that abactinal surface, which is slightly concave, is raised above base of rays. Margin rounded. Abactinal surface and sides covered with rather robust, irregular plates, close-set, in the integument. Plates scattered in central portion of disk. Between the plates are large papular pores. Papulæ single (one to a pore), large, vermiform, numerous. Plates irregularly convex abactinally, and surmounted by 1 to 3 short, round-tipped, untapered spinelets (0.50–1 mm. long). Scattered among these are numerous minute, crossed pedicellariæ. The spinelets are so small that they give scarcely more than a roughened appearance. They are longer on the sides of the disk, but there do not exceed 1 mm. in length. Numerous spinelets bear several of the microscopic pedicellariæ on their sides. Genital region, at base of ray, covered with thin membrane under which are various sized, very irregular, small, loosely imbricating plates, which increase in size as they recede from disk, the largest plates being in outer part of genital region. Between the plates issue numerous single and generally distributed papulæ. The genital region is crossed by rather irregular bands of small imbricating ossicles, which are more prominent than those just mentioned. These cross ribs are about 5 mm. apart and there are about 6 or 7 of them. They bear a few scattered slender needle-like spinules. On proximal third of the inflatable portion of genital region the bands are usually very irregular or interrupted; the plates are generally less prominent, and spines are few and irregularly distributed, there being none on sides of ray. On the more prominent parts of each rib, in the mid-genital region, are 5 very slender spinules on either side, and 2 or 3 others in the mid-dorsal region shorter than the rest. The 3 lateralmost spinules are much the longest (4 to 5 mm.). All are covered with membrane beset with numerous minute, crossed pedicellariæ. (Usually about half the spinules have lost the membrane entirely.) Membrane between the spiniferous ribs closely beset with minute pedicellariæ like those of disk and spines. These, in fact, extend the whole length of ray, and upon the adambulacral plates. Beyond, or distally from the genital region, the abactinal surface of ray is covered with thin translucent membrane beset with very numerous, scattered microscopic, cross pedicellariæ, which often show a tendency to collect in irregular clusters or bunches. The transverse ribs of the genital region are here represented by prominent lateral keel-like ridges, consisting of 5 plates fused together. The missing dorsal portion between two ridges of either side, i. e., that portion which would complete the transverse rib, is reduced to an indistinct line of rudimentary plates, only visible when the membrane is quite dry. The lateral ridges are often not exactly opposite on 2 sides of a ray. They are 5 or 6 mm. apart. Just beyond ovarial region, each bears 5 lateral spines, which are quickly reduced to 4, and on outer half of ray there are but 3. The outer spine, that next to adambulacral plate, is usually longest (8 to 9 mm.), the other two nearly as long. The fourth or fifth when present is considerably shorter. These spines are thickly invested with a membraneous sheath, the end of which is often expanded into a flap. Rays are united at their base by lateral and adambulacral plates for about 7 or 8 mm. from disk. Beyond interbrachial angle the lateral or marginal plates may be seen for 15 mm., beyond which point they are only evident at the bases of the ribs and lateral ridges.

Adambulacral plates fairly prominent, forming a rounded margin to the wide furrow. Viewed from the actinal side they are broader than long (length 1 mm. approximately). At base of ray height of plate as seen from side is about 2 mm. Interspaces or sutures between plates broad. Arma-

ture consists of a single large, perpendicular spine, which at about the middle of the genital inflation measures 4 to 4.5 mm. in length. Base of spine is cylindrical or very slightly tapering, but the distal half is compressed and the tip truncate, often slightly flaring. Sometimes a groove runs along outer part of spines; or two parallel grooves are present. Less commonly the tip is bifid for a millimeter. Beyond genital inflation the spines rapidly become much slenderer and tapering, the chisel-like character being lost; and on the outer half of ray they are quite delicate and about 2.25 to 2.5 mm. long. The outer side of large spines is covered by membrane, beset with numerous microscopic pedicellariæ, which are also present on outer face of the adambulacral plates. Furrow side of both spines and plates is devoid of pedicellariæ. The smaller spines bear a flap of membrane beset with numerous pedicellariæ.

Actinostome wide, its diameter 15 to 18 mm. (diameter of disks 27 to 30 mm.). Peristomial membrane thin, semitransparent. Mouth plates with lateral process extending across mouth of ambulacral furrow and meeting a similar expansion from the opposite plate, thus roofing over the proximal end of the radial nerve. The two processes, which are at the inner end of their respective plates, sometimes, but not usually, ankylose. A small spinelet is borne on the end of this lateral process. Three other subequal, short, round-tipped mouth spinelets are present on the free (actinostomial) margin of each plate, the inner at a distance nearly equal to its own length from the median sutural line. All bear near the tip a small tuft of minute pedicellariæ attached to an insignificant membrane. On actinal surface at aboral end of plate is a single spinelet similar to but a trifle larger than the marginal spinelets. The furrow margin of each mouth plate is deeply excavated to accommodate the first pair of tube feet.

Madreporic body rather small, subtubercular, situated on the rounded margin of the disk. Striations few, coarse, radiating.

Color in life, yellowish pink.

Localities: Type (no. 21190, U. S. National Museum) from station 3828, south coast of Molokai Island, 319 to 281 fathoms, broken shells and gravel; bottom temperature, 43.8° F. Taken also at station 3992, vicinity of Kauai Island, 528 fathoms (approximately), fine gray sand and mud; bottom temperature, 39.6° F.; 2 specimens in all.

There are four other known species of this genus, all from the Atlantic: *Odinia elegans* Perrier, *O. robusta* Perrier, and *O. semicoronata* Perrier from off the coast of Morocco, and *O. pandina* Sladen from the Faröe Channel. *O. pacifica* is thus the first member of the genus to be taken in the Pacific Ocean. It approaches, most nearly, *O. pandina* and *O. robusta*, but is less spiny than either of these forms, although quite as large. The skeleton of the basal portion of arms and disk is well developed.

The depth given for the second station at which this species was captured is probably too great. The trawl encountered a soft, muddy bottom, and it was estimated that the net was dragged at depths between 500 and 400 fathoms.

Genus BRISINGA Asbjørnsen.

Brisinga Asbjørnsen, Fauna Litt. Norvegiæ, 1856, Andet Hefte, p. 95. Type *Brisinga endecacnemos* Asbjørnsen.

Key to Hawaiian species of Brisinga.

a. Adambulacral armature prominent, crowded. Lateral spines stout and long.

b. Rays 14. Disk large; annular ridges very numerous, close together; 2 or 3 prominent actinal adambulacral spines ..... *panopla*

bb. Rays 9. Disk small; annular ridges not so numerous, or close together ..... *alberti*

aa. Adambulacral armature much less crowded.

b. Rays 15. Size large; disk large; annular ridges not very numerous, nor close together ..... *evermanni*

bb. Rays 10. Disk rather small, thin. Rays delicate, spines weak. Annular ridges rather close together, numerous and prominent. Prickles absent from abactinal membrane of rays. *fragilis*

Brisinga panopla, new species.

Pl. XLIII, fig. 3; pl. XLIV; pl. XLV, fig. 3; pl. XLVII, figs. 2, 2a-f.

Rays 14. R = 235 mm., approximately; r = 13 mm. R = 18 r approximately. Depth of disk, 7 mm.; breadth of ray at base, 7 mm.; breadth at widest part of genital inflation, about 10 mm.; at middle of ray, 6 mm.

Rays very long and rather narrow. Genital inflation extensive though not prominent. The genital region extends to about two-fifths or one-half the length of ray. Ray subcylindrical at base, very gradually and but slightly widening along the genital inflation; then even more gradually tapering to the long, very attenuate extremity. Slightly to markedly depressed on basal region; subtriangular beyond genital region, with a broad median ambulacral ridge, due to the collapsing of this abactinal membrane on the ambulacral ridge. Disk large. Lateral arm-spines long and rigid. Disk rather large, subdepressed, but the abactinal surface raised above base of rays, the margin being rounded. Abactinal membrane thin, closely beset with delicate, small, sharp, distinctly spaced prickles about 0.5 mm. in length. Scattered among the prickles are comparatively few microscopic pedicellariæ, together with almost exactly similar but very much larger pedicellariæ. The two distinct sizes are very characteristic of this species, the larger not being found in the three following forms. Interradial plates inconspicuous, with several small tubercles. The abactinal membrane of rays is thin and translucent. The inner part of ray is crossed by numerous (35 to 49) transverse, annular ridges, rather closely placed, which extend 10 to 20 mm. beyond the limits of gonads. These ridges are flexuous and often very irregular. They are placed opposite, or correspond to each adambulacral plate (beyond the eighth), although occasionally a plate will be skipped. Frequently 2 or more neighboring ridges are joined near the radial line, and thence prolonged to the opposite side as a single ridge, corresponding to what would ordinarily be the interspace. The ridges are narrow but prominent, and are composed of many elongated ossicles imbricated end to end, the sutures between which are clearly distinguishable when a ray is dried. Along top of ridge are numerous small, spaced, sharp prickles. The thin membrane investing the ridge is covered with microscopic pedicellariæ. Between the annular ridges the abactinal membrane bears illy defined, transverse bands of minute pedicellariæ, which conform to the course of the adjacent ridges. Among these minute pedicellariæ (which do not form prominent saccular bands) are numerous much larger pedicellariæ, especially abundant on the sides of ray. Near base of ray the integument bears numerous scattered prickles of small size. Beyond genital region abactinal membrane is thickly sprinkled with pedicellariæ, on some rays clustered into well-defined transverse bands. Only the smaller size is present on the outer attenuate portion of the ray.

Ambulacral furrow fairly wide. Adambulacral plates short (2 mm. in middle of genital region, 1.25 mm. at base of ray). They are higher than long in basal half of genital region, but gradually become lower distad. Each ossicle is slightly concave toward the middle, so that the whole series might be roughly likened to the vertebral column of a bony fish. Armature has appearance of being crowded, and can be better understood from the figure than from description. At aboral end of each plate is a slender, delicate spinelet 2 mm. in length, directed across furrow, reaching and often touching its neighbor of opposite side. External to this, on aboral edge of plate, is an oblique transverse series of 2 or 3 spines, 2 on some plates, 3 on others, these two numbers often but not always alternating. When there are 3 spines (4 counting the furrow spinelet) that next to the furrow spinelet (near base of ray, at least) is delicate, about equal in length to the former and likewise directed across furrow, but farther along the ray it becomes larger and upright. This spinule is absent from those plates which have only 2 actinal spines. The next two spines are the same on all the plates. The inner is about 4 to 4.5 mm. long, sharp, slender, and upright. The outermost is fully twice as long (9 mm. in middle of genital region, even 10 mm. on some arms) and the base occupies the greater part of actinal surface of its plate. This spine is sharp, slender, and tapering, and like the others, is invested by a thin membrane extending beyond the tip in a short vermiform flap, the whole length of the spine being closely beset with minute pedicellariæ. The other 2 or 3 actinal spines are crowded at the tips and to a less extent along their length with the larger pedicellariæ also. Near adoral margin of plate in a longitudinal line with the innermost actinal spine (the one which is frequently absent) is a delicate spinelet, shorter than the furrow spinelet, directed upwards or backwards, and like it beset with a cluster of the larger pedicellariæ. Actinal and lateral faces of adambulacral plates covered with scattered pedicellariæ of the two sizes, all of them being very deciduous. As is usual in this family, the spines are characterized by rather prominent longitudinal ridges or flutings, which are especially marked in the largest actinal spines. The series of the latter gradually shortens toward the base of the ray, and at fifteenth adambulacral plate they begin to become truncate. From here they rapidly shorten, while the tip becomes broader and flaring, and is marked by numerous papillæ, while the lateral flutings of the stem end in similar peripheral papillæ on the crown. These spines are not precisely square-tipped, but are cut obliquely so that the summit slopes toward the furrow.

The lateral spines begin at about thirteenth or fourteenth adambulacral plates, and are articulated to lateral plates at the extreme ends of the transverse annular ridges. Consequently the lateral spines are opposite nearly all of the adambulacral plates, to a dorso-lateral process of which they superficially appear to be articulated. Beyond genital region and annular ridges the lateral spines continue as closely spaced for a while, but on the outer third or fourth of ray they are opposite every alternate adambulacral plate, with a few irregularities. Lateral spines are long throughout ray, but longest at about the middle (11–12 mm.). They are covered with membrane beset with minute pedicellariæ. Between the first lateral spine and the disk are about 10 to 12 lateral plates, free from the adjacent adambulacrals, and irregular as to position and shape.

Actinostome large, measuring 18 mm. across. Mouth plates inconspicuous, excavated on the margin toward furrow, and with a lateral prolongation extending into mouth of ambulacral furrow. Armature consists of a delicate spinelet about 1.75 mm. in length situated on margin toward actinostome, and another similar but stouter spinelet on tip of the lateral prolongation and directed across furrow. Both have a thin membranous investment expanded at end and covered with minute pedicellariæ (smaller size.). On actinal surface, near outer end of each plate, is a stout pointed spine about 4 to 5 mm. in length, invested in a membranous sheath which is continued beyond the tip as a long vermiform sacculus covered with microscopic pedicellariæ. The spines of companion plate-stand close together and are directed over actinostome. They are the representatives of the truncate spines of the following adambulacral plates, the first 5 or 6 of these having long saccular prolongations at the tips. At base of large actinal mouth spine are 2 slender spinelets, one (2 mm. in length) being longer than the other. Both are directed across the furrow and bear pedicellariæ.

Madreporic body small, sub-tubercular, situated on the margin of the disk.

Color in life, salmon pink, yellowish in tone; in alcohol, bleached ashy.

Variations: A specimen (one arm) from 4178 has quite definite abactinal saccular cross bands of pedicellariæ, more prominent than in type, beyond the genital region. A specimen from 3828 is remarkable in having a dorso-lateral line of ossicles, on either side of the ray about 4 or 5 mm. above the upper margin of the adambulacral plates, which extends nearly to the extremity of the genital region. This series of ossicles crosses and connects consecutive transverse annular ridges. On one ray these are absent. There is no disk preserved, and the specimen is otherwise badly mutilated, but appears fairly typical except in the character just cited.

Localities: Type (no. 21191, U. S. National Museum) from station 4177, vicinity of Niihau Island, 451–319 fathoms, gray sand and globigerina; bottom temperature 41°. Taken also at station 4178, 319–378 fathoms, coral sand, rocks, and pebbles (same locality); station 3828, south coast of Molokai Island, 319–281 fathoms, broken shells and gravel; station 3992, vicinity of Kauai Island, 528 (approximately) fathoms, fine gray sand and mud; 4 specimens in all.

This species is quite distinct from any other Hawaiian form, and is characterized by the numerous annular ridges of the arms and by the almost entire absence of prickles from the abactinal membrane. The armature of the adambulacral and mouth plates, figured in detail, will also furnish additional characters. As compared with the following species, the disk is much larger, the rays more numerous, the annular ridges more numerous, and practically every detail of armature different, as shown by the accompanying figures. *Brisinga panopla* shows relationship with *B. multicostata* Verrill, and *B. cricophora* Sladen, both from the Atlantic, but differs from these species in the details of its structure.

Brisinga alberti, new species.

Pl. XLV, figs. 1, 2; pl. XLVI, figs. 2, 3; pl. XLVII, fig. 4, 4a; pl. XLVIII, figs. 1, 1a–c.

Rays 9. R=230+mm.; r=11 mm. R=about 23 r. Breadth of ray at base, 6–7 mm.; at widest part of genital inflation, 8.5 mm.; at middle of ray, 5.5 mm.

Rays long and rather narrow, depressed in genital region, which is only very slightly inflated, and which extends about half the total length of ray. Ray gently tapering to an elongate and extremely attenuate extremity. Beyond genital region it is subtriangular in section, with a broad truncate median carination, due to the collapsing of thin abactinal membrane on the ambulacral ridge. Disk small. Lateral spines very long. Disk much smaller than that of *B. panopla*, depressed, the abactinal surface being on a level with base of rays. Abactinal membrane rather thin and densely crowded with small, sharp, tapering, delicate, skin-covered spinelets, 0.75 mm. in length. These are thickest and stoutest in center of disk. Membrane covering plates and spinelets bears scattered microscopic

crossed pedicellariæ. Interradial plate is conspicuous, confined to lateral wall of disk. Abactinal membrane of rays thin and translucent. Basal half of each ray crossed by 25 to 32 transverse, annular ridges, equidistantly placed, and not nearly so close together as in *B. panopla*. These ridges, which begin at the very base of ray, are narrow, prominent, and irregular. They are placed, roughly speaking, opposite alternate adambulacral plates, although there are irregularities in this respect. Occasionally 2 or more neighboring ridges are joined irregularly in the median radial line and variously prolonged to opposite side as a single ridge or as 2 ridges. These annular ridges, as in other members of the genus, are composed of slender ossicles, imbricated end to end, which bear rather widely separated prickles and microscopic pedicellariæ. Membrane between ridges is beset with minute prickles, quite numerous at base of ray, but gradually disappearing until they are practically absent beyond middle of genital region. Besides these, there are transverse bands of microscopic pedicellariæ, more or less interrupted on the median radial line. On outer part of ray, beyond genital region, the pedicellariæ may be scattered, or gathered into more or less definite transverse bands.

Ambulacral furrow fairly wide. Adambulacral plates short and low in genital region (about 2 mm. long). They are longer than high, about as broad as long, and are sharply concave toward the center, as in other species of the genus. Armature recalls that of the preceding species in general features. Furrow spinelets are 2, delicate, slender, the aboral situated on the aboral margin of plate, well within furrow; the adoral, very near but not exactly on the adoral edge, slightly more actinad than the aboral spinelet. Aboral spinelet measures about 2 mm. in length, but on outer part of ray becomes slightly longer. Near base of ray adoral spinelet equals the aboral in length, or is slightly longer (3 mm.), but distad is somewhat shorter. Rarely a second and shorter spinelet is placed just above the adoral, in furrow. All these are sheathed in membrane, which sometimes extends beyond the tip and is covered with microscopic pedicellariæ. On alternate plates (or less often) the aboral furrow spinelet is lacking. Actinal spines 2, in a slightly oblique transverse series along aboral margin of plate in a line with the aboral furrow spinelet (when that is present). In basal portion of some rays there may be 3 actinal adambulacral spines. The inner spine, which is much smaller than outer, measures about 5 mm. in length in mid-genital region. The outer spine, articulated to a slight boss on plate, is slender and needle-like and attains a length of 15 or 16 mm. at outer part of genital region. Both spines are invested in membrane, which is prolonged beyond the tip and is closely crowded with microscopic pedicellariæ. Beyond genital region the adambulacral plates are longer and slenderer. There are usually 2 furrow spines, the aboral the longer, and but 1 actinal spine. On plates adjacent to which there is a long lateral spine (usually alternate plates), this actinal spine (which represents the outer long spine of the basal region of ray) is shorter (about 4–8 mm., according to position); but on alternate plates (between lateral spines) it is very long and slender (9–14 mm., according to position). Eight or 9 of the outer actinal spines at base of rays are peculiarly modified, as in *B. panopla*, *B. cricophora*, and *B. multicostata*. These spines are short (4–8 mm.) and robust, with fluted sides and an expanded, truncate, papillose summit, somewhat resembling a composite flower. They decrease in length toward the actinostome, the first 1 or 2 spines being usually clavate, acute. In the other direction they pass insensibly into the slender pointed variety. Actinal and lateral surfaces of adambulacral plates are covered with scattered pedicellariæ.

Lateral spines begin at about the eighth or tenth adambulacral plate and are articulated to lowermost plate of the annular ridges. These lateral plates are at first free from the adambulacrals, but on the outer half of the rays appear to be firmly fused thereto. At base of ray the lateral spines are about 8 mm. long and gradually increase in length until, in the mid-genital region, they are 15 mm. long. This length is kept up to very near the tip of ray, when they abruptly shorten. Lateral spines are invested with a membranous sheath extending beyond tip in a short vermiform sacculus and closely beset with microscopic pedicellariæ. The rays are united at base by first lateral plate of either ray. These are rather massive and are articulated also, in the direction the disk, to the interradial plate, which forms an elbow projecting outward slightly in the interradial angle at a level with the lateral plates. Lateral plates in basal part of genital region few and irregular as to form and arrangement.

Actinostome not so large in proportion to disk as in the preceding species (about 11 mm.). Mouth plates deeply excavated on margin toward furrow (hour-glass shaped). There is the usual prolongation, which is not so pronounced as in some species, extending from inner furrow corner of plate into the mouth of furrow. Spines numerous. Armature as follows: (1) A short, slender spinelet

(1.5–2 mm. long) on margin toward actinostome and near median suture; a similar spinelet on the lateral prolongation, pointed over furrow. Both bear numerous microscopic pedicellariæ. (2) Along actinal face of plate a curved longitudinal row of 4 tapering spines and spinules extending outward from the inner marginal spine. The third from the outer end is longest (4 mm.), and thence they diminish in length toward either end of series. All are invested with membrane and bear the usual microscopic pedicellariæ. Usually these spines stand erect, but occasionally the outermost is directed over the furrow.

Madreporic body circular, subtubercular, 2 mm. in diameter, and situated at the edge of the disk on curvature uniting lateral and abactinal surfaces. It is situated on the upper arm of the interradial plate, which is more prominent than the others, and is covered densely with spinelets like those of remainder of abactinal surface.

Color bleached ashy in alcohol; probably salmon pink or red in life. The writer does not recollect any member of this family taken during the Hawaiian cruise which departed from this tint. No color is recorded for this species, however.

Variations: A specimen from 3992 has, at base of ray, a third furrow spinelet situated just aborally to the usual adoral spinelet, and less commonly there may be a group of 3 in this position. Similarly there may be 2 aboral furrow spinelets, one situated above the other. The aboral spinelet, which is often typically absent on alternate plates, seems very seldom lacking in this specimen. On the outer part of ray the armature is arranged like that of type, although rarely 2 adoral furrow spinelets are present. In other respects this specimen is fairly typical and does not appear to be a different species.

Localities: Type (no. 21192, U. S. National Museum) from station 4177, vicinity of Niihau Island, 451–319 fathoms, gray sand and globigerina; bottom temperature, 41°; 4 specimens. Taken also at station 3992, vicinity of Kauai Island, between 400 and 500 fathoms; fragments.

This species is characterized by its small disk, extensive genital region, with rather widely separated genital costæ; by the very long lateral and actinal adambulacral spines, and by the armature of the adambulacral and mouth plates. It is a constantly 9-rayed form, and presents some resemblances to *B. cricophora* Sladen from 390 fathoms, northwest of St. Thomas, Virgin Islands. It is, however, widely different from this form in its much smaller disk, fewer rays (11 in *cricophora*), and in the details of its armature. While *B. alberti* resembles the preceding species in the more general features of the adambulacral armature, it is at once separable on account of its smaller disk, fewer rays, fewer and more widely separated genital costæ, and numerous other details shown in the accompanying figures.

Named for my father, Dr. Albert K. Fisher.

Brisinga evermanni, new species.

Pl. XLIII, fig. 2; pl. XLV, fig. 4; pl. XLVII, fig. 3; pl. XLVIII, figs. 2, 2a–c.

Rays 15. R = at least 270 mm. (ray-tip gone); r = 15 mm. R = about 18 r. Breadth of ray at base, 6 mm.; at widest part of genital inflation (70 mm. from disk) 8 or 9 mm.; at distal limit of genital region (100 mm. from disk) 6 mm.

Rays long and slender and somewhat contracted at base. Thence they widen quickly but evenly into the slightly inflated genital region, which is depressed when the ray is straight. Genital region maintains a fairly uniform width nearly to its distal limit, when ray gradually and evenly begins to taper toward the long and attenuate extremity. Portion beyond genital region is more or less depressed in its proximal fourth, but is marked by the usual truncate carination of ambulacral ridge on its outer three-fourths. Disk large. Costal ridges of arms rather widely separated. Lateral spines long.

The disk, which is large, has been somewhat mutilated, but its essential characters remain intact. Abactinal surface is raised but slightly above the bases of arms, and is beset with very short, sharp prickles, distinctly spaced but closely set. Each prickle is invested with a thick membranous sheath, so that it appears papilliform. Around bases of prickles are numerous crossed pedicellariæ. Each spinelet is borne on a slight boss of its plate, and near the border of disk where prickles are shorter each of these slight tubercles may bear a group of 2 or 3 prickles. Surrounding anal opening is a compact group of stout, tapering, sharp spinules, the longest 2 mm. in length and all membrane-invested. Some of the papillæ of general surface appear truncate, especially toward center of disk, but the

invested prickle is always sharp. Interradial plates nearly naked, expanded and spatulate at upper end. Below they narrow and bend outward in a slight elbow, expanding a bit on the interbrachial angle to form 2 distinct condyles for the articulation of proximal marginal plate of each adjacent ray. The interradial plate is marked by a shallow longitudinal sulcus or occasionally by two lateral sulcuses, and a central low ridge. Abactinal membrane of rays thin and translucent. The basal two-fifths of ray, occupied by genital region, is crossed by 32 to 38, usually about 35, transverse, calcareous annular ridges or costæ. These ridges begin very nearly at the base of the ray, where they are much closer together (1–2 mm.) than over outer two-thirds of genital region (3–7 mm.). Ridges are narrow and prominent, composed of imbricating calcareous rods which appear very firmly ankylosed, although sutures can usually be distinguished. These ossicles bear numerous microscopic pedicellariæ, and a longitudinal row of numerous, distinctly spaced, sharp, prominent prickles, which are absent from the lateral plates adjacent to each alternate adambulacral. A few of the ridges are incomplete and extend only slightly beyond median radial line; but consecutive ridges appear never to join as is commonly the case in the two foregoing species. While often sinuous in the median radial portion, the ridges are fairly regular and spring from a lateral plate adjacent to each alternate adambulacral, which plate bears the lateral spine, and on the outer two-thirds or three-fourths of the ray, appears firmly ankylosed to its neighboring adambulacral plate. The membrane between ridges bears microscopic pedicellariæ, which are arranged in 1 to 4 narrow bands, according to width of interval. These bands are inconspicuous, are parallel with the calcareous ridges, and on some rays are almost entirely absent. Beyond genital region the pedicellariæ are grouped in transverse lateral bars, and in median radial line are scattered. There are a few tegumentary prickles at base of ray, but these do not extend far beyond disk. Consequently, especially in a dried specimen, the integument of arms appears fairly smooth.

Ambulacral groove has the appearance of being rather wide and shallow in the genital region. Adambulacral plates form a rounded margin to furrow; short (2 mm. long) in genital region; about as high as long; conspicuously longer than in *B. panopla*. On distal portion of ray the plates, as is usual, are longer and slenderer, and all are concave in the middle, especially toward furrow. Armature as follows: (1) A slender furrow spinelet, invested with an inconspicuous membranous sheath bearing microscopic pedicellariæ, situated aborally on furrow margin. At base of genital region this spinelet is about 1.5 to 2 mm. long, and seldom exceeds 2 mm. throughout the ray. (2) On the actinal surface of each plate a long slender spine articulated to a slight prominence or tubercle. On alternate plates this spine is often slightly longer, and placed slightly more laterally, a second shorter spinule (3–4 mm.) being present between it and the furrow spinelet. Sometimes this smaller actinal spinule is absent, although the longer spine is nevertheless placed more to the outer side of the plate. Frequently on plates with 2 actinal spines, the single furrow spinelet is absent. The larger actinal spine measures 8 mm. near base of ray, increasing to 13 or 14 mm. at distal limit of the genital region, whence it again gradually becomes shorter toward tip of ray. All spines are sheathed in membrane, covered with pedicellariæ, but the latter do not appear so conspicuous or numerous as in the 2 preceding species. Adambulacral plates of distal half of arm bear but one actinal spine. On a very few rays there is also but one actinal spine on most of the plates of the proximal half of the ray. Some of the actinal spines at base of ray appear to bear a truncate, flaring tip, but these spines are longer and slenderer than in either of the foregoing species. Most of them are broken so that it is impossible to determine how many possess the enlarged tip.

The lateral spines are articulated to the lateral plates, adjacent to about every alternate adambulacral plate or those which have 2 actinal spines. Lateral spines are present beyond tenth adambulacral plate, and thence very rapidly increase in length, so that in mid-genital region they attain 12 or 13 mm., which is increased occasionally to 15 mm. at the distal limit of the costal region. Membrane and pedicellariæ present.

Actinostome very large, 20–21 mm. in diameter. Mouth plates fairly large, deeply excavated on side toward furrow for accommodation of first tube foot. Actinal surface of plate plane. Armature as follows: (1) A short spinelet (1.5 mm. long) situated on the middle of the margin toward actinostome, and a second slightly larger spinelet, on the tip of the lateral prolongation, directed across the mouth of ambulacral furrow. (2) On extreme outer end of plate is a stout tapering actinal spine about 4 or 5 mm. long. One of the spines of two companion plates is sometimes shorter than the other. Except for this single spine the general surface of the mouth plate is smooth. All the spines bear

microscopic pedicellariæ, which are attached to a thin membranous investment often expanded into a flap at tip.

Madreporic body small and sub-tubercular, situated near margin of disk, at inner edge of interradial plate.

Color in alcohol yellowish white; in life very probably salmon-red or pink.

Locality: Type (no. 21193, U. S. National Museum) from station 3992, vicinity of Kauai Island, between 400 and 500 fathoms, fine gray sand and mud, bottom temperature 39.6°; 1 specimen.

This species is characterized by the large disk, 15 rays, well spaced and well developed genital costæ, which are fairly regular and about 35 in number; by the absence of prickles from the integument, except at very base of arms; by the armature of the adambulacral plates and of the mouth plates.

Named for Dr. Barton Warren Evermann.

Brisinga fragilis, new species.

Pl. XLVI, fig. 1; pl. XLVIII, figs. 3, 3a–c.

A constantly 10-rayed species, smaller than any of the preceding *Brisingas*, and with less conspicuous spines. Some of the characters, especially the armature of the adambulacral plates, are subject to considerable variation. The specimens can be divided into about 5 groups, on account of certain small differences which are certainly not specific in character. The group with the largest number of specimens has been considered the typical form, and the others are referred to in the following description as "variation *a*, *b*, *c*, and *d*," merely as a method of systematizing the diagnosis.

R=171 mm.; r=7.5 mm. R=23 r. Breadth of ray at base 4 mm.; at widest part of genital region (40 mm. from disk) 7 mm.; at last annular ridge 4.5 mm.

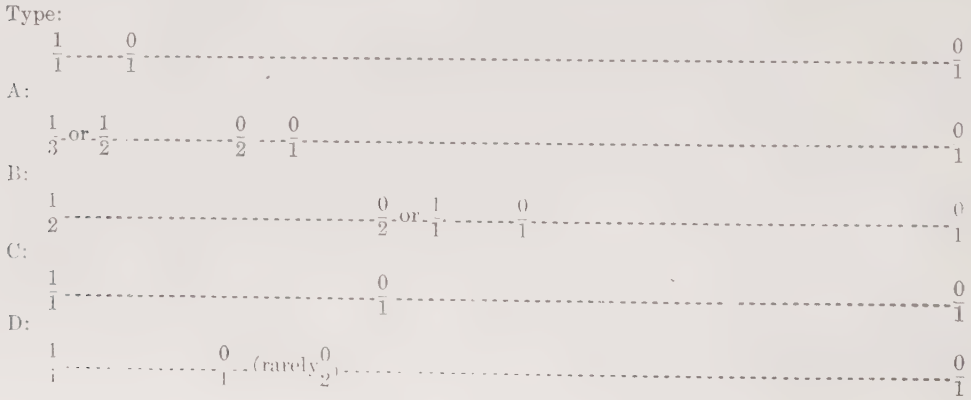
Rays long and slender, rather more inflated in the genital region (which is often quite depressed) than are those of the preceding species. Rays very narrow at base and loosely articulated to disk. They gradually expand in genital region, the widest part being about one-fourth distance from base to tip. Outer part very gradually tapering to an attenuate extremity. Annular ridges extend about one-half length of ray, and beyond them the integument is exceedingly thin and delicate. Annular ridges narrow and very prominent. Integument of arms devoid of prickles. Disk small. Lateral spine delicate, shorter than in preceding species.

Disk small and depressed, the abactinal surface being about even with base of arms. Integument crowded with small, illy defined, roundish, subtubercular plates, surmounted by one or two spiculiform spinelets, quite small and covered with thin membrane. Around base of each of these spinelets are scattered a few minute pedicellariæ. The plates are more crowded about the eccentric anal opening, the spinelets immediately surrounding which are larger than the rest. Each spinelet appears to end in 2 or 3 minute points. Interradial plate small. Closely united with it are the proximal marginal plates of either adjacent ray, the three plates forming a rude letter Y reversed. The upper, unpaired bar represents the interradial plate, and the diverging arms the marginals, set at a lower level and closely fused with the interradial. The outer ends of the 2 diverging bars form a double condyle for articulation with the second marginal plate of each ray. The three plates appear superficially as one, and their exposed surface is slightly concave and wholly devoid of spinelets.

Abactinal membrane of rays thin and translucent and entirely free from integumentary prickles. Basal half of ray is crossed by from 24 to 28 annular carinations or calcareous ridges, rather thin but prominent. Even in the same specimen there is considerable difference in the number of ridges on the several rays. What might be called primary costæ are usually opposite each alternate adambulacral plate; but on arms with more than the usual number of costæ the ridges may be opposite 2 or 3 consecutive plates, then skip one, and so on. In addition to the 24 to 28 ridges, which extend completely from side to side of ray, there may be an inconspicuous rudimentary ridge between them on the median line, and not reaching the adambulacral plates of either side. These incomplete ridges, which are usually quite short, do not have any regularity of occurrence. On some rays they are totally absent; on others there is one for about every third intercostal space. Occasionally a primary ridge does not extend wholly across the ray, and all are rather irregularly sinuous in the median line. The plates which compose the annular ridges are compressed, and bear along the keel-like summit distinctly spaced, spiculiform spinelets with swollen bases and very sharp points. There are numerous microscopic pedicellariæ, also, along sides of these ossicles. Membrane between ridges bears one or two narrow transverse bands of microscopic pedicellariæ. These bands are continued beyond the

costal region, one opposite each adambulacral plate, throughout ray. Variation *d:* One specimen from station 4131 has more numerous annular ridges, 35 to 40. The difference is solely due to the greater number and prominence of the secondary ridges, which practically occur in each intercostal space, and reach nearly or quite to the adambulacral plates. They differ from the primary ridges in that there is no larger (infero-) marginal plate joining the slender ossicles with the corresponding adambulacral plate. The secondary ridges are therefore never fused with the adambulacral plates, a small free space always intervening. Variations *a* and *b:* Secondary costæ very few and rudimentary. Bands of pedicellariæ in intercostal spaces are prominent and saccular, and the ridges are also invested in a soft membrane covered with minute pedicellariæ. Primary costæ, 18 to 26.

Ambulacral furrow wide and shallow. Adambulacral plates (1.5 to 2 mm. in length) are about twice as long as wide (in the middle) and rather more than twice as long as high (seen from side). Plates constricted in middle, but especially concave on the furrow face. Armature, especially the furrow spinelets, somewhat variable in arrangement and number. The typical form will be first described, and then the several variations. Armature in type and similar specimens is simplest of all. There is but one furrow spinelet situated near the adoral end of the plate, except on the 6 to 12 proximal plates, where an exactly similar spinelet is present on the extreme aboral end. Both spinelets, which are directed across the furrow, are about 1 to 1.25 mm. in length, are invested in a very thin membranous sheath expanded at the tip, and there covered with microscopic pedicellariæ. On the actinal surface, rather nearer to the aboral edge than to the center of the plate, is a delicate and fragile spinule about 4 mm. in length, invested in a delicate membrane on which are microscopic pedicellariæ. This spinule is more delicate than is usual in this genus for the principal adambulacral spine. On account of their extreme fragility, nearly all of these spines are broken in the type series. Variation *a*: On the proximal 12 or 15 plates (basal fifth of ray) there are 2 adoral furrow spinelets, 1 right above and slightly aborally from the other, and 1 aboral spinelet as in the type. Rarely there are 3 adoral spinelets at the very base of the ray. On the next few plates, about the fifteenth to twentieth, the aboral spinelet is missing. On the outer three-fourths of the ray the furrow armature is that of the type—1 adoral spinelet. The actinal spine is a trifle stouter and longer than the other specimens (7 mm. in mid-genital region). (1 specimen, station 3817.) Variation *b:* Resembling *a;* proximal plates with 3 furrow spinelets, 2 adoral and 1 aboral. The succeeding 2 or 3 plates lack the aboral spinelet. Outer half of ray as in type. Actinal spine as in type, not so stout or prominent as in *a*. On some rays the aboral spinelet extends nearly to middle of ray, and the 2 or 3 succeeding plates may have only 1 adoral and 1 aboral spinelet. (2 specimens, stations 3892, 4041.) Variation *c:* This is near the typical form, the only difference being that the plates with 1 adoral and 1 aboral spinelet extend about one-third the length of the ray instead of being confined to its immediate base. (2 specimens, stations 3914, 4096.) Variation *d:* Multicostate form with rather stouter actinal spines than type. Furrow armature is practically the same as type, except that occasionally on basal third of ray there will be 2 instead of 1 adoral spinelet. (1 specimen, station 4131.) If the furrow armature is represented graphically by a common fraction, the numerator standing for the aboral spinelet, and the denominator for the adoral spinelet of each plate, the typical formula would be $\frac{0}{1}$. If the ray be represented by a line, the base at the left, then the proportion of plates with each type of armature to the whole ray in the different varieties will be about as follows:



Lateral spines are not nearly so prominent as in the preceding species. They begin at about seventh adambulacral plate and are articulated to a lateral plate at the end of each primary annular ridge. At the base of ray the spines are about 3 to 4 mm. long; in mid-genital region 6 to 7 mm., and on outer third of ray 4 to 5 mm., being here slightly longer than the actinal adambulacral spinules. In variations *a* and *b* the lateral spines are longer than in the type, but only slightly. Lateral spines membrane-covered and beset with minute pedicellariæ.

Actinostome rather large, 9 mm. in diameter. Mouth plates fairly prominent, not deeply excavated toward furrow, nor is there a prolongation of the inner furrow corner of plate as is usual in this genus. Each plate has a slightly curved edge toward actinostome, and rises gently toward medium suture, which is conspicuous. Armature as follows: (1) A marginal series of 3 short spinelets on edge toward actinostome. These spinelets are 1.5 mm. long, and the lateralmost is directed across mouth of furrow. If a line is drawn from outer furrow corner to inner suture corner of each plate, it would pass (usually) through the bases of 3 spinelets which stand on the actinal surface, the outermost on the very edge of plate and often directed across the furrow. The innermost of the series stands in center of plate and is stoutest but scarcely longer than marginal spinelets. Median spine of this group, which occasionally stands on the slightly excavated furrow margin, is slender and longer. All spinelets have an exceedingly delicate membraneous sheath, beset with comparatively few pedicellariæ. In variation *a* the actinal spinelets form a more transverse than diagonal series.

Madreporic body of fair size, subtubercular, being much larger than interradial plate, just adcentrally to which it is situated. Striations coarse, irregular.

Color in life, coral red to light salmon pink.

Localities: Type (no. 21194, U. S. National Museum) taken from station 3824, south coast of Molokai Island, 222–498 fathoms, coral rocks, broken shells; bottom temperature, 49.5–41.5°. Typical specimens also from the following localities: Stations 3865, 3910, 3920, 4090, 4166.

Record of localities.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3817	South coast of Oahu	320	Coarse lava, coral sand, shells.
3865	Northeast approach to Pailolo channel, between Maui and Molokai.	256–283	Fine volcanic sand, rocks.
3892	North coast of Molokai	328–414	Fine gray sand.
3910	South coast of Oahu	311–337	Fine gray sand and mud.
3911	do	289–292	Gray sand and mud.
3920	do	280–265	Gray sand, broken shells.
4041	West coast of Hawaii	382–253	Gray mud, foraminifera.
4090	Northeast approach to Pailolo channel	304–308	Fine gray sand.
4091	do	308–306	Do.
4096	do	272–286	Do.
4131	Vicinity of Kauai	309–257	Do.
4166	Vicinity of Bird Island	293	Coral sand, rocks, foraminifera.

This is the commonest *Brisinga* in Hawaiian waters, and seems quite distinct from any form heretofore described. It is related more or less closely to *B. exilis* Fisher from off the California coast.

EXPLANATION OF DESCRIPTIVE TERMS.

The technical terms in starfish descriptions are rather numerous. On account of the large number of new forms in the Hawaiian collections, it has been necessary to give rather thorough descriptions, more especially as certain of the species belong to new and often obscure genera. The following glossary is supplied for students unacquainted with starfishes:

abactinal, pertaining to the dorsum or back, as opposed to actinal.

abactinal area, usually used in speaking of the abactinal paxillar area of phanerozoniate species.

actinal, ventral, used in speaking of the surface on which the mouth opens.

actinal intermediate plates, plates paving the actinal surface, between the inferomarginal and adambulacral plates.

actinal interradial areas, actinal area of disk, paved with actinal intermediate plates.

actinolateral membrane, membrane uniting the actinolateral spines. (Pl. XL, fig. 1.)

actinolateral spines, in the Pterasteridæ the long spines articulated on the body-frame close to the adambulacral plates which form the lateral or marginal web in *Pteraster*, and support the whole actinal floor in *Hymenaster*. See plate XL, figure 1.

actinostome, the opening in the actinal skeleton bounded by the mouth plates and first adambulacral plates.

adambulacral plates, plates bordering ambulacral furrow.

ambulacral furrow, the V-shaped furrow running the length of the rays, in which are the tube-feet; actinal in position.

ambulacral plates, plates roofing the furrow.

aperture papillæ, in the Pterasteridæ, papilliform spines opposite the segmental apertures. (Pl. XXXVIII fig. 6, ap. p.)

bivalved, see pedicellaria.

excavate, see pedicellaria.

fascioles or *fasciolar grooves*, grooves between special transverse ridges of the marginal plates, occurring over the suture between plates; usually bordered by specialized spinelets. (Pl. IV, fig. 2, shows several fascioles cleared of spines.)

foraminate, see pedicellaria.

forcipiform, *forficiform*, see pedicellaria.

furrow, the ambulacral furrow.

furrow spines, used sometimes in referring to the spinelets on the furrow margin of the adambulacral plates.

inferomarginal plates, the lower or ventral series of marginal plates, usually very prominent in all the Phanerozonia.

interbrachial arc or *angle*, arc between 2 adjacent rays.

madreporic body, the more or less prominent calcareous sieve marking the external opening of the water-vascular system, situated in an interradius of the abactinal area.

marginal plates, the more or less prominent plates defining the contour of the body in the Phanerozonia; usually discernible in other orders.

mouth plates, the modified innermost adambulacral plates.

osculum or *ocular orifice*, the large central opening guarded by valves in the supradorsal membrane of the Pterasteridæ.

papulæ, the small vermiform, or occasionally compound, dermal branchiæ which protrude through holes in the skeleton.

papular, pertaining to papulæ.

papularium, specialized papular area of Pontasterinæ.

paxillæ, or more correctly *paxilli*, columnar or hour-glass-shaped ossicles, with more or less flaring bases which bear at the summit a group of spinelets, usually small. Of these the marginal series is usually different from the rest, and divergent, so as to cover the intervening spaces between the paxillæ. These grade into uniformly granulated plates by many transitional forms. (See Pl. III, fig. 3a, 3d.)

pedicellaria, the curious little pincer-like structure occurring in great numbers on some species of starfishes. In some families they are apparently absent. They may be classified as follows:

a. Sessile: without a special basal piece.

1. Incipient or pseudo-pedicellariæ. The jaws do not spring from a specialized depression or foramen.

1*a*. Simply a group of opposable spinelets; *spiniform*. (Pl. II, fig. 4, ped.; Pl. IX, fig. 1a.)

1*b*. The spinelets more or less specialized, and on separate plates, arranged in little combs; *pectinate*. (Pl. X, fig. 3.)

1*c*. With 2 or 3 specialized jaws. (e. g. *Luidia*, Pl. XVI, fig. 1.)

2. Tong-shaped or alveolar pedicellariæ. The jaws spring from a specialized pit or foramen.

2*a*. The jaws have no specialized depressions into which they fit when opened. The jaws are higher than wide, usually spatulate (pl. XVI, figs. 3, 4, 4a; pl. XXVI, fig. 1b); *foraminate*.

2*b*. The jaws are low and wide, with no specialized depression into which they fit when opened. Pedicellariæ are mere slits, or resemble a miniature bivalved shell (pl. XXVI, fig. 5; pl. XXVII, fig. 2a; pl. XXXIII, fig. 1); *bivalved*.

2*c*. The jaws, when opened, fit into a specialized depression (pl. XXVII, fig. 1; pl. XXXI, figs. 2a, 4a, 4b); *excarate*.

b. Pedunculate. Each pedicellaria consists of a basal piece and 2 jaws.

3. The jaws are attached to end of the basal piece nearest them, i. e., the jaws do not cross near the base (pl. XLI, fig. 2); *forficiform* or "*straight*."

4. The 2 jaws cross one another. (Pl. XLI, figs. 3b, 4b; pls. XLVII, XLVIII); *forcipiform* or "*crossed*."

peristomial membrane, the membrane surrounding the mouth.

R or *major radius*, the distance from center of disk to tip of ray.

r or *minor radius*, the corresponding interradial dimension.

segmental aperture in Pterasteridæ, small aperture at base of each actinolateral spine and at outer edge of adambulacral plate leading from nidamental cavity to exterior; guarded by the aperture papilla, q. v. (Pl. XXXVIII, fig. 6.)

spines, spinules, spinelets, relative terms purely; the spines being the largest, providing any conspicuous spinous appendages are present.

spiracula, small openings in the supradorsal membrane of Pterasteridæ. (Pl. XL, fig. 2.)

superambulacral plates, especially well-developed in the Astropectinidæ, are small internal ossicles extending from the ambulacral plates to the corresponding inferomarginal, or sometimes to the intermediate plates when the actinal intermediate areas are extensive. (Pl. II, fig. 5f, *sa*.)

superomarginal plates, the upper or dorsal series of marginal plates defining the contour of the abactinal surface in most Phanerozonia.

supradorsal membrane, "the veil-like covering or external independent tissue whereby the dorsal nidamental cavity is formed in the Pterasteridæ. The membrane is supported above the true abactinal surface of the animal by the paxillæ, which consist of a long columnar pedicel surmounted by a crown of fine, more or less elongate spinelets. In the majority of forms belonging to this family, fine muscular fibrous bands extend between the tips of the spinelets and constitute a more or less regular fibrous network; and the general tissue of the supradorsal membrane which fills in the interspaces or meshes, is usually perforated by small contractile pores styled *spiracula* by Sars." Sladen.

terminal or *ocular plate*, the unpaired plate at the tip of the ray.

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EXPLANATION OF PLATES.

(Except where indicated otherwise, all drawings and photographs were made by the writer.)

PLATE I.

Fig. 1. *Astropecten polyacanthus*, abactinal view; enlarged to slightly over 2 diameters.
Fig. 2. *Astropecten velitaris*, abactinal view; enlarged to about $1\frac{3}{4}$ diameters.
Fig. 3. *Astropecten pusillulus*, abactinal view, ×2.
Fig. 4. *Astropecten ctenophorus*, abactinal view, ×2.
Fig. 5. Same, actinal view.

PLATE II.

Fig. 1. *Astropecten polyacanthus.* Fifth inferomarginal plate and neighboring adambulacral plates. The upper adambulacral plate is devoid of spines, while in the lowermost (adoral) the furrow spines are standing perpendicularly, ×8. 1*a*. *Astropecten polyacanthus.* Two paxillæ from the base of ray, ×20. 1*b*. Paxilla from ray, about halfway to tip, ×20.

Fig. 2. *Astropecten velitaris.* Fifth inferomarginal plate and neighboring adambulacral plates, ×10. 2*a*. Paxillæ from base of ray, ×20.

Fig. 3. *Astropecten ctenophorus.* First 3 inferomarginal plates and neighboring adambulacral plates, ×10. 3*a*. Paxillæ from near center of disk, ×20. 3*b*. Second, third, and fourth supero- and infero-marginal plates seen from the side, ×10. 3*c*. Tenth adambulacral plate, ×10. 3*d*. Mouth plates; the first adambulacral shown on the right, ×15.

Fig. 4. *Astropecten pusillulus.* Third, fourth, and fifth inferomarginal plates and adjacent adambulacral plates. a^1, first actinal series of adambulacral spinelets; a^2, second series; *ped.*, pedicellarian apparatus, ×10. 4*a*. Mouth plates, ×10. 4*b*. Paxillæ from disk near border of interradial area, ×20.

Fig. 5. *Astropecten productus.* Sixteenth to eighteenth superomarginal plates, and abactinal end of inferomarginals, showing the large lateral spines, ×5; *sup.*, superomarginal plates. 5*a*. Paxillæ near base of ray, ×10. 5*b*. Side view of a paxilla from base of ray, ×10. 5*c*. Adambulacral plates from near proximal end of furrow, ×8; *mar.*, inferomarginal plate. 5*d*. Median furrow spine, ×8. 5*e*. Mouth plates, ×4. 5*f*. Cross section taken at about the middle of ray to show better the relation of plates. *ab.*, abactinal integument; *ad.*, adambulacral plate; *am.*, ambulacral plate; *inf.*, inferomarginal plate; *sup.*, superomarginal plate; *sa.*, superambulacral ossicle.

PLATE III.

Fig. 1. *Ctenophoraster hawaiiensis.* Adambulacral plates, actinal intermediate plates, and lower end of sixth inferomarginal, ×8; *int. pl.*, intermediate plate; *inf.*, sixth inferomarginal. The spines have been removed from the median adambulacral plate. 1*a*. Eighteenth and nineteenth superomarginals, from above, to show the lateral spines on upper end of the inferomarginals, ×8. 1*b*. Tip of an inferomarginal spine, much enlarged. 1*c*. Diagram of an inferomarginal plate. The circles represent the articulation surface for spines. 1*d*. Paxillæ, about midway between median radial line and edge of paxillar area, from near base of ray, ×10. 1*e*. Median spine of furrow series (adambulacral), ×8.

Fig. 2. *Psilasteropsis cingulata.* Madreporic body and neighboring paxillæ, ×10. 2*a*. Adambulacral plates and inferomarginal plates near base of ray, ×7. 2*b*. Paxillæ, edge of interradial area, ×10.

Fig. 3. *Psilaster attenuatas.* Adambulacral and inferomarginal plates, ×5. 3*a*. Paxillæ from a large specimen, base of ray, ×10. 3*b*. Paxillæ from base of ray, showing usual position of spinelets, ×10. 3*c*. Paxillæ from a form with broader rays, base of ray, ×10. 3*d*. A single paxilla, from the side; large specimen, ×10.

PLATE IV.

Fig. 1. *Astropecten productus.* Abactinal view of one arm and parts of three others, slightly less than natural size.

Fig. 2. Same. Actinal view of base of ray, showing mouth plates and inferomarginal armature. The spines have been removed from a few inferomarginal plates to show their shape, and the fasciolar grooves, nearly ×2.

Fig. 3. Same. Abactinal view, showing lateral inferomarginal spines, nearly ×2.

PLATE V.

Fig. 1. *Ctenophoraster hawaiiensis.* Abactinal surface. Natural size.

Fig. 2. Same. Actinal surface.

PLATE VI.

Fig. 1. *Ctenophoraster hawaiiensis.* A portion of disk and base of rays enlarged to a trifle over 2 diameters.

Fig. 2. Same. Actinal view. The actinal intermediate plates are cleared of spinelets in one interradius.

PLATE VII.

Fig. 1. *Psilasteropsis cingulata.* Side view of an arm, enlarged nearly 2 diameters.

Fig. 2. Same. Two immature individuals, slightly larger than natural size.

Fig. 3. Same. Abactinal view of adult, slightly larger than natural size.

Fig. 4. *Psilaster attenuatus*, slightly larger than natural size.

PLATE VIII.

Fig. 1. *Psilaster attenuatus.* Mouth plates and actinal intermediate areas, enlarged to slightly less than 2 diameters.

Fig. 2. *Psilasteropsis cingulata.* Actinal view, enlarged to slightly less than 2 diameters.

Fig. 3. *Astropecten callistus.* Actinal view, enlarged to slightly less than 2 diameters.

Fig. 4. *Tritonaster craspedotus.* Actinal view, enlarged to slightly less than 2 diameters.

PLATE IX.

Fig. 1. *Tritonaster craspedotus.* Twelfth to fourteenth marginal plates showing the prominence of the inferomarginal series with their long spines, ×8. 1*a*. Fourth and fifth inferomarginal plates and adjacent adambulacrals, ×10. A pedicellarian apparatus is shown on one plate otherwise cleared of actinal spines; *int.* intermediate plates. 1*b*. Paxillæ from abactinal interradial area, ×20. 1*c*. Side view of a larger interradial abactinal paxilla, ×20. 1*d*. Paxilla from radial line, middle of ray, ×20. 1*e*. Mouth plates, side view, showing particularly position of marginal spines, ×6. 1*f*. Adambulacral plate, middle of ray, opposite eleventh inferomarginal, ×10. 1*g*. Mouth plates, actinal aspect, ×8. 1*h*. Marginal plates of outer half of ray, viewed directly from above, to show prominence of inferomarginals; ×2. All covering has been removed. 1*i*. Enlargement of a couple of plates, ×8. 1*j*. Marginal plates from side, showing relative height of the 2 series; *sup.*, superomarginals. 1*k*. Medium spine of adambulacral furrow series, ×10.

Fig. 2. *Patagiaster nuttingi.* Ninth and tenth adambulacral and fifth and sixth superomarginal plates, ×10. Intermediate plates (*int.*) are shown between the two. 2*a*. Paxillæ from base of ray, ×10.

Fig. 3. *Dipsacaster nesiotes.* Paxillæ from base of ray showing also the prominent papular pores, ×10. 3*a*. Side view of a paxilla from the abactinal interradial area, ×15.

Fig. 4. *Astropecten callistus.* Ninth and tenth adambulacral plates and adjacent inferomarginals, ×10. The actinal intermediate plates are seen between the two. 4*a*. Mouth plates, ×8. 4*b*. Paxillæ from base of ray, at side, ×10. 4*c*. Paxilla from another individual, ×10. 4*d*. Some of its spinelets enlarged.

PLATE X.

Fig. 1. *Psilasteropsis cingulata.* Actinal view, ×1.3. Drawn by H. R. Johnson.
Fig. 2. *Dipsacaster nesiotes.* Abactinal view, ×1.3. 2*a*. Fourth and fifth adambulacral plates and one intermediate plate, ×8. From one plate the inner actinal series of spinelets has been removed. Drawn by H. R. Johnson. 2*b*. One of the furrow spines seen from the side.
Fig. 3. *Cheiraster snyderi.* Mouth plate, first 3 adambulacrals, actinal intermediate plates, and inner edge of first 3 inferomarginals, showing particularly the peculiar pedicellariæ characteristic of the genus, ×8.
Fig. 4. *Cheiraster inops.* Sixth inferomarginal plate and 2 adjacent adambulacral plates, ×10.
Fig. 5. *Cheiraster horridus.* Third and fourth inferomarginal plates and adjacent adambulacrals, ×8. 5*a*. Abactinal surface, radial line, near center of disk, ×10.
Fig. 6. *Pseudarchaster myobrachius.* Fourth inferomarginal plate and adjacent adambulacral plates, ×8. 6*a*. Radial and adradial paxillæ near center of disk, ×10.
Fig. 7. *Pseudarchaster jordani.* Fourth and fifth adambulacral plates and adjacent actinal intermediate plates, ×8. 7*a*. Radial paxillæ, ×10.

PLATE XI.

Fig. 1. *Tritonaster craspedotus.* Abactinal view, ×2.
Fig. 2. *Astropecten callistus.* Abactinal view, ×2.

PLATE XII.

Fig. 1. *Dipsacaster nesiotes.* Actinal view, nearly twice natural size.
Fig. 2. Same. Basal portion of arm and part of disk, nearly ×2.
Fig. 3. *Patagiaster nuttingi.* Actinal view, about ×1.5.

PLATE XIII.

Fig. 1. *Luidia hystrix,* about five-sixths natural size.
Fig. 2. Same, young, ×1.3.

PLATE XIV.

Fig. 1. *Luidia hystrix,* portion of disk and basal part of arms enlarged to 1.75 diameters; abactinal view.
Fig. 2. Same, actinal surface, ×1.75.

PLATE XV.

Fig. 1. *Luidia magnifica.* Portion of abactinal surface of arm enlarged to nearly 2 diameters.
Fig. 2. Same. Abactinal view, slightly less than one-half natural size.
Fig. 3. Same. Actinal surface of ray near disk. Enlarged to nearly 2 diameters.

PLATE XVI.

Fig. 1. *Luidia magnifica.* Adambulacral, intermediate, and inferomarginal plates from proximal fourth of ray, ×5. A second adambulacral and adjacent intermediate plates are shown. *ap.*, outer adambulacral pedicellaria; *ip.*, intermediate pedicellaria; *inf. p.*, inferomarginal pedicellaria. 1*a*. Paxillæ from near base of ray, from the 2 inner regular series, ×10. The median radial line is to the left and the spines point aborad. Peculiar compound papulæ are shown in upper left corner, the circle indicating where the pedicels of the paxillæ have been broken off.
Fig. 2. *Luidia hystrix.* Adambulacral plates in basal fourth of ray, ×8. Top of figure is aborad. 2*a*. Paxillæ from near base of ray, from inner regular row but one, ×10.
Fig. 3. *Mediaster ornatus.* Adambulacral and adjacent actinal intermediate plates, ×10. 3*a*. Paxilla from specimen having prominent abactinal pedicellariæ, ×10. 3*b*. Paxillæ, radial and adradial from near base of ray; type, ×10.
Fig. 4. *Nereidaster bowersi.* Adambulacral and adjacent actinal intermediate plates, near base of ray, showing actinal pedicellariæ, ×8. 4*a*. Radial paxilla, abactinal, ×8.
Fig. 5. *Pentagonaster ammophilus.* Radial plates, ×8. 5*a*. Adambulacral plates, ×10.
Fig. 6. *Tosia* (*Plinthaster*) *ceramoidea.* Adambulacral plates, ×10. 6*a*. Radial and adradial plates, abactinal, near center of disk, ×10.

PLATE XVII.

Fig. 1. *Patagiaster nuttingi.* Abactinal surface, slightly less than twice natural size.
Fig. 2. *Cheiraster inops.* Do.
Fig. 3. *Cheiraster horridus.* Do.
Fig. 4. *Nereidaster bowersi.* Abactinal view of ray and a little of interradial portion of disk. Enlarged slightly less than 2 diameters.

PLATE XVIII.

Fig. 1. *Cheiraster snyderi.* Abactinal view of type, slightly less than ×2.
Fig. 2. *Cheiraster horridus.* Actinal view, slightly less than ×2.
Fig. 3. *Cheiraster snyderi.* Actinal view, slightly less than ×2.

PLATE XIX.

Fig. 1. *Pseudarchaster myobrachius.* Abactinal surface, ×1.66. 1*a*. Actinal surface, ×1.66. 1*b*. Same, young. Abactinal surface, ×1.8. 1*c*. Same. Actinal view, ×1.8.
Fig. 2. *Pseudarchaster jordani.* Actinal view, ×1.5. 2*a*. Abactinal view, ×1.33.
Fig. 3. *Goniodiscides sebæ.* Portion of abactinal surface to show papular areas, ×1.33.

PLATE XX.

Fig. 1. *Mediaster ornatus.* Abactinal view, slightly less than ×2.
Fig. 2. Same. Actinal view, ×1.7.
Fig. 3. *Antheniaster epixanthus.* Portion of actinal surface enlarged about twice to show mouth plates and adambulacral armature. Typical form.

PLATE XXI.

Fig. 1. *Nereidaster bowersi.* Actinal view; enlarged about ×1.7.
Fig. 2. *Tosia (Ceramaster) micropelta.* Actinal view, ×1.85.

PLATE XXII.

Fig. 1. *Pentagonaster ammophilus.* Abactinal aspect, nearly ×1.5.
Fig. 2. Same. Actinal view.
Fig. 3. *Tosia (Plinthaster) ceramoidea.* Actinal view, slightly larger than natural size.
Fig. 4. Same. Abactinal aspect.

PLATE XXIII.

Fig. 1. *Astroceramus callimorphus.* Abactinal view, ×1.1.
Fig. 2. Same. Portion of abactinal surface enlarged to about 2 diameters.
Fig. 3. Same. Portion of abactinal surface enlarged. The granuliform appearance of the abactinal plates is due to a bead-like roughness of the plates themselves, not to deciduous granules; but granules surround each plate, and are present on the general surface of the marginal plates.

PLATE XXIV.

Fig. 1. *Calliderma spectabilis.* Abactinal aspect of a medium-sized individual, about natural size.
Fig. 2. Same. Actinal surface.
Fig. 3. *Zoroaster spinulosus.* Abactinal view, about natural size.

PLATE XXV.

Fig. 1. *Calliderma spectabilis.* Portion of abactinal surface of same specimen as plate XXIV, figure 1, ×1.83.
Fig. 2. Same. Portion of abactinal surface at base of ray, showing adambulacral and actinal spines; type, about ×1.8.
Fig. 3. Same. Region of the actinostome; type, about ×1.8.

PLATE XXVI.

Fig. 1. *Antheniaster epixanthus.* Abactinal aspect of type, natural size. 1*a*. Adambulacral plate from proximal portion of series, showing the heavy membrane as it appears in life, the granules beneath being nearly obscured; type, ×8. 1*b*. A dried specimen to show appearance after the membrane has shrunken, ×8. This specimen is one of the long-armed forms and possesses a pedicellaria at the adoral side of a number of the plates. (See pl. XXIX, fig. 2). 1*c*. Radial and either adradial row of plates, obscured by integument, about one-third distance from center of disk to tip of ray, ×5.

Fig. 2. *Asterodiscus tuberculosus.* Adambulacral plates. Drawn by O. E. Hyde. 2*a*. Dorsal tubercles enlarged. Drawn by O. E. Hyde.

Fig. 3. *Calliderma spectabilis.* Seventh and eighth adambulacral plates, ×5.

Fig. 4. *Tosia (Ceramaster) micropelta.* Adambulacral plates, ×10. Drawn by O. E. Hyde. 4*a*. Radial abactinal plates, ×12. Drawn by O. E. Hyde.

Fig. 5. *Evoplosoma forcipifera.* Mouth and first 3 adambulacral plates, ×7. 5*a*. Inner mouth spine, ×7. 5*b*, 5*c*. Spines from actinal surface of adambulacral plates, ×7.

PLATE XXVII.

Fig. 1. *Calliaster pedicellaris.* Adambulacral plate and adjacent actinal intermediate plates in proximal third of series, showing an open and a closed pedicellaria, ×8.

Fig. 2. *Gilbertaster anacanthus.* Abactinal view, ×2. (The outlines of disk inclose fig. 2*b*.) Drawn by H. R. Johnson. 2*a*. Three adambulacral plates (about one-third R in position), showing one of the large bivalved pedicellariæ on the furrow margin. 2*b*. Abactinal plates showing the pedicellariæ and flat granules or ossicles by which the plates are covered, ×7. *p.*, papulæ. 2*c*. An actinal interradial area to show pedicellariæ, granules, furrow margin, and mouth plates. Drawn by H. R. Johnson.

Fig. 3. *Astroceramus callimorphus.* Two adambulacral plates and one actinal intermediate plate, the latter bearing a pedicellaria, ×8.

Fig. 4. *Evoplosoma forcipifera.* Abactinal view, ×1.33. (The outlines of disk inclose fig. 4*b*.) Drawn by H. R. Johnson. 4*a*. Madreporic body and adjacent plates as they are in life, showing tubercles, vermiform papulæ, and the granules covered with a soft membraneous sheath; ×5. An abactinal pedicellaria is also shown. 4*b*. Side view of abactinal spines, ×5.

PLATE XXVIII.

Fig. 1. *Calliaster pedicellaris.* Portion of abactinal surface, ×1.8.

Fig. 2. Same. Actinal surface, ×1.8.

Fig. 3. *Asterodiscus tuberculosus.* Side view of ray to show the 2 series of marginal plates, ×1.8.

PLATE XXIX.

Fig. 1. *Antheniaster epixanthus.* Long-rayed form, abactinal surface of a dried specimen, ×1.35.

Fig. 2. Same. Actinal surface, ×1.35.

Fig. 3. *Evoplosoma forcipifera.* Actinal surface after specimen had been dried, ×1.83.

Fig. 4. *Linckia diplax.* Actinal view of disk and adjacent portion of rays, ×1.83.

PLATE XXX.

Fig. 1. *Leiaster callipeplus.* Abactinal view, slightly more than ×1.7. 1*a*. Same. Skin removed to show arrangement of plates. Portion of ray has been opened along dorsal line and spread out.

Fig. 2. *Ophidiaster rhabdotus.* Abactinal view, slightly larger than natural size.

Fig. 3. *Ophidiaster triseriatus.* Abactinal view, about ×4.2. Photo by N. H. Kent.

Fig. 4. *Ophidiaster sclerodermus.* Abactinal view, slightly larger than natural size. 4*a*. Actinal surface showing extensive actinal intermediate areas.

PLATE XXXI.

Fig. 1. *Calliaster pedicellaris.* Abactinal view, natural size. Drawn by H. R. Johnson.

Fig. 2. *Ophidiaster sclerodermus.* Actinal surface showing furrow spines and position of pedicellariæ. 2*a*. A pedicellaria from the abactinal surface, much enlarged.

Fig. 3. *Leiaster callipeplus.* Furrow armature, viewed from furrow.
Fig. 4. *Ophidiaster lorioli.* Abactinal surface showing adradial plates and position of pedicellariæ, ×10. 4*a*. One of the abactinal pedicellariæ. 4*b*. Same, the jaws being closed to show the special depressions for jaws and slight fluting on outer face of latter. 4*c*. Furrow margin and actinal series of papular pores, ×10. 4*d*. Furrow spinelets as seen from furrow, showing accessory granules, about ×20. The right is toward mouth.
Fig. 5. *Ophidiaster tenellus.* Radial plates, ×8. 5*a*. Furrow margin in the proximal third of the ray, ×10.
Fig. 6. *Ophidiaster squameus.* Radial and either adradial series of plates, ×10. 6*a*. Furrow margin and actinal surface, the plates below the papular pores being inferomarginal, ×10. 6*b*. Furrow spinelets viewed from furrow, ×20. Mouth is toward the right, accessory granules are shown between the spinelets.
Fig. 7. *Ophidiaster triseriatus.* Furrow spines, ×10. 7*b*. Abactinal pedicellaria.
Fig. 8. *Ophidiaster rhabdotus.* Furrow spines.
Fig. 9. *Linckia diplax.* Furrow spines viewed from furrow; mouth is toward left.

PLATE XXXII.

Fig. 1. *Pentaceros hawaiiensis.* Abactinal view of type. Reduced to about 0.7 natural size.
Fig. 2. Same. Young specimen showing the incipient lophial spines and the lack of other spines, about ×0.7.
Fig. 3. Same. View of furrow margin of a large specimen showing a triplicanthid armature to adambulacral plates; 2 and 3, second and third series; (first and second actinal series).
Fig. 4. *Asterodiscus tuberculosus.* Abactinal aspect of a young specimen, ×1.8.
Fig. 5. Same. Actinal surface, ×1.8.

PLATE XXXIII.

Fig. 1. *Pentaceros hawaiiensis.* Portion of actinal surface of type, enlarged.
Fig. 2. *Asterodiscus tuberculosus.* A ray and portion of disk of the type enlarged, showing madreporic body and form of tubercles, ×1.83.

PLATE XXXIV.

Fig. 1. *Asterodiscus tuberculosus.* Abactinal view of type, three-fourths natural size.
Fig. 2. Same. Portion of actinal surface of type, ×1.83.
Fig. 3. *Pentaceros hawaiiensis.* "Apical region" of type, enlarged. The anal opening is seen near the center, and the madreporic body in the lower left-hand corner.

PLATE XXXV.

Fig. 1. *Henricia robusta.* Actinal view of type, enlarged about 1.6 diameters.
Fig. 2. Same. Abactinal aspect.
Fig. 3. *Henricia pauperrima.* Actinal view of type, enlarged about 1.6 diameters.
Fig. 4. Same. Abactinal aspect.

PLATE XXXVI.

Fig. 1. *Mithrodia bradleyi.* Abactinal view; slightly over 0.7 natural size.
Fig. 2. Same. Abactinal surface of one arm enlarged about ×1.8.

PLATE XXXVII.

Fig. 1. *Mithrodia bradleyi.* Actinal surface, ×1.83.
Fig. 2. *Mithrodia.* Actinal surface of a ray of a peculiar specimen, possibly a freak, ×1.83.
Fig. 3. Same. Abactinal surface of same specimen. Compare with pl. xxxvi, fig. 2.
Fig. 4. *Ophidiaster squameus.* Abactinal view, enlarged about 4.6 diameters. Photo by N. H. Kent.

PLATE XXXVIII.

Fig. 1. *Inseropoda insignis.* Fourth to eighth adambulacral plates and adjacent actinal intermediate plates, ×8. The actinal adambulacral spinelets (*ad. 2*) are shown in 2 different positions, the upper being the more usual. The fans of the actinal plates are just to the left of these. *ad. 1.*, furrow spinelets. 1*a*. Abactinal plates, interradial, about 30 mm. from edge of disk, and from radial line.

Fig. 2. *Henricia robusta.* Adambulacral plates, ×10. 2*a*. Abactinal surfaces, middle of arm, ×10.

Fig. 3. *Henricia pauperrima.* Abactinal surface near base of ray, ×20. 3*a*. Seventh and eighth adambulacral plates seen from furrow, showing the 2 furrow spinelets, ×12.

Fig. 4. *Valvaster striatus.* Adambulacral plates, near base of R, ×10. 4*a*. Marginal plates viewed from the side, showing the very large superomarginal pedicellariæ, and inferomarginal spine, ×10.

Fig. 5. *Pteraster reticulatus.* Adambulacral spines, ×5. *ap. p.*, aperture papilla. 5*a*. Supradorsal membrane near center of disk.

Fig. 6. *Hymenaster pentagonalis.* Adambulacral plates, ×8. *ap. p.*, aperture papilla. 6*a*. Mouth plates, ×3. *1st. ap.*, first aperture papilla, imbedded in actinolateral membrane. 6*b*. An actinal mouth spine from cotype.

Fig. 7. *Benthaster eritimus.* Paxillæ much enlarged, and seen from side to show height of pedicels and general surface of supradorsal membrane (dotted line).

PLATE XXXIX.

Fig. 1. *Pteraster reticulatus.* Actinal surface of type, enlarged about 1.8 diameters.

Fig. 2. Same. Abactinal surface, slightly larger than natural size.

Fig. 3. *Ophidiaster lorioli.* Abactinal surface of type, enlarged about 2.7 diameters. Photo by N. H. Kent.

PLATE XL.

Fig. 1. *Benthaster eritimus.* Actinal surface (interradial), showing actinolateral spines, membrane, adambulacral plates and armature, and the mouth plates, ×10. The first aperture papilla is multifid and is lodged in the actinolateral membrane; the rest are free and lanceolate-acuminate. The circular bodies showing through the actinolateral membrane are the large bi- or tri-lobed, fleshy glandular papulæ. A number of the adambulacral plates have the furrow spinelets removed. 1*a*. A portion of supradorsal membrane much magnified, to show spiracula, muscle fibers, and spines. 1*b*. Abactinal aspect of entire animal, ×3. The supradorsal membrane is broken open in places.

Fig. 2. *Hymenaster pentagonalis.* Small portion of supradorsal membrane near radial line showing spiracula and papillæ, ×8.

Fig. 3. *Asthenactis papyraceus.* Plates of side of ray in a dry specimen, a few of the dorsal plates showing above, ×8. The fascicles of spinelets have been removed from most of the plates, and the integument has entirely dried up. In life the plates are not superficially visible. 3*a*. Actinal surface showing one interradius, adambulacral and mouth plates, and the incipient actinolateral membrane, enlarged about 5.5 times. 1, 2, 3, first to third adambulacral plates. 4*s*. Spines on the fourth adambulacral plate. 3*s*′. Spines on process of third plate, but forming a single series with those of fourth (4*s*). 2*s*′. Similar spines on process of second plate.

PLATE XLI.

Fig. 1. *Hymenaster pentagonalis.* Abactinal view of cotype, ×0.75.

Fig. 2. *Zoroaster spinulosus.* Adambulacral plates, ×10.

Fig. 3. *Hydrasterias verrilli.* Actinal surface, showing furrow margin and actinal spines, ×8. 3*a*. Radial and either adradial series of plates in a dried specimen, ×6. 3*b*. Abactinal pedicellaria.

Fig. 4. *Coscinasterias* (*Distolasterias*) *euplecta.* Furrow margin and actinal spines, ×8. 4*a*. Furrow spines seen from furrow, ×8. 4*b*. Abactinal pedicellariæ, ×35. 4*c*. Teeth of same.

PLATE XLII.

Fig. 1. *Coscinasterias* (*Distolasterias*) *euplecta*. Actinal view of an arm and disk. Type; enlarged nearly 2 diameters.
Fig. 2. Same. Abactinal aspect.
Fig. 3. Same. Young specimen, ×1.83.
Fig. 4. Same. View of side of arm of a prepared specimen to show arrangement of plates, ×1.83.
Fig. 5. *Zoroaster spinulosus*. Actinal aspect of type, ×1.83.
Fig. 6. Same. View of side of ray to show spinules and radial tubercles, ×1.83.

PLATE XLIII.

Fig. 1. *Odinia pacifica*. Abactinal view, slightly less than natural size.
Fig. 2. *Brisinga evermanni*. Abactinal surface of an arm which has been partially dried, about ×1.8.
Fig. 3. *Brisinga panopla*. Abactinal aspect of genital region of a ray, ×1.8.

PLATE XLIV.

Fig. 1. *Brisinga panopla*, slightly reduced.

PLATE XLV.

Fig. 1. *Brisinga alberti*, slightly reduced.
Fig. 2. Same. View of side of a portion of an arm, enlarged about 1.8 diameters.
Fig. 3. *Brisinga panopla*. Portion of ray, side view, to show particularly the actinal adambulacral spines and costal spinelets, ×1.83.
Fig. 4. *Brisinga evermanni*. Actinal surface of ray. Tube feet have been removed, ×1.83.

PLATE XLVI.

Fig. 1. *Brisinga fragilis*. Disk and 3 rays. The disk and upper ray belong to "variation *a*." The lowest ray is the typical form, while the middle belongs to "variation *d*," in which the secondary costæ, only slightly developed in the typical form, extend across the abactinal surface, but do not fuse with the lateral plates. Enlarged about 1.7 diameters.
Fig. 2. *Brisinga alberti*. Actinal surface enlarged, showing the curious actinal adambulacral spines near disk, ×1.83.
Fig. 3. Same. Abactinal surface, ×1.83.

PLATE XLVII.

Fig. 1. *Odinia pacifica*. Side of a portion of ray, mid-genital region, showing actinal adambulacral and first lateral spines, ×2. 1*a*. Same, from a dried specimen, ×3. *ad. s.*, adambulacral spines; *ad.*, adambulacral plates; *l. s.*, lateral spines; *c. r.*, costal ridge. 1*b*. Side of ray, beyond middle, showing lateral spines, ×3. 1*c*. Mouth plates, ×4. The lateral process on the right is fused with that of the other side of furrrow. 1*d*. Pedicellaria from adambulacral spine.
Fig. 2. *Brisinga panopla*. Side of ray, about 40 mm. from disk, or just beyond the club-shaped actinal spines, ×3. Lateral spines, fore-shortened. 2*a*. Adambulacral plates about 40 mm. from disk, ×4. Many of the spines are shown without pedicellariæ. 2*b*. Adambulacral plates at about 65 mm. from tip of arm, ×4. 2*c*. Mouth plates, ×5. *ad. s.*, first adambulacral spines; *am. f.*, ambulacral furrow; *m. s.*, marginal spines; *m. s.'*, furrow spines of mouth plates; *ms.''*, actinal spine; *sac.*, sacculus bearing pedicellariæ (see 2*d*). 2*d*. One of the larger pedicellariæ from a large adambulacral spine. 2*e*. Twelfth adambulacral spine, ×7. 2*f*. Seventh adambulacral spine, ×7.
Fig. 3. *Brisinga evermanni*. Side of ray, about 44 mm. from disk, ×7.
Fig. 4. *Brisinga alberti*. Side of ray, about 40 mm. from disk, ×3. 4*a*. Pedicellaria from adambulacral spine near base of ray.

PLATE XLVIII.

Fig. 1. *Brisinga alberti.* Adambulacral plates and armature, 50 mm. from disk, showing also the lateral spines (*l. s.*), ×4. Lower spines without membrane. 1*a*. Same, from outer third of arm, ×4. 1*b*. Mouth plates, ×5. The first adambulacral is also shown. 1*c*. Sixth adambulacral spine, +7.

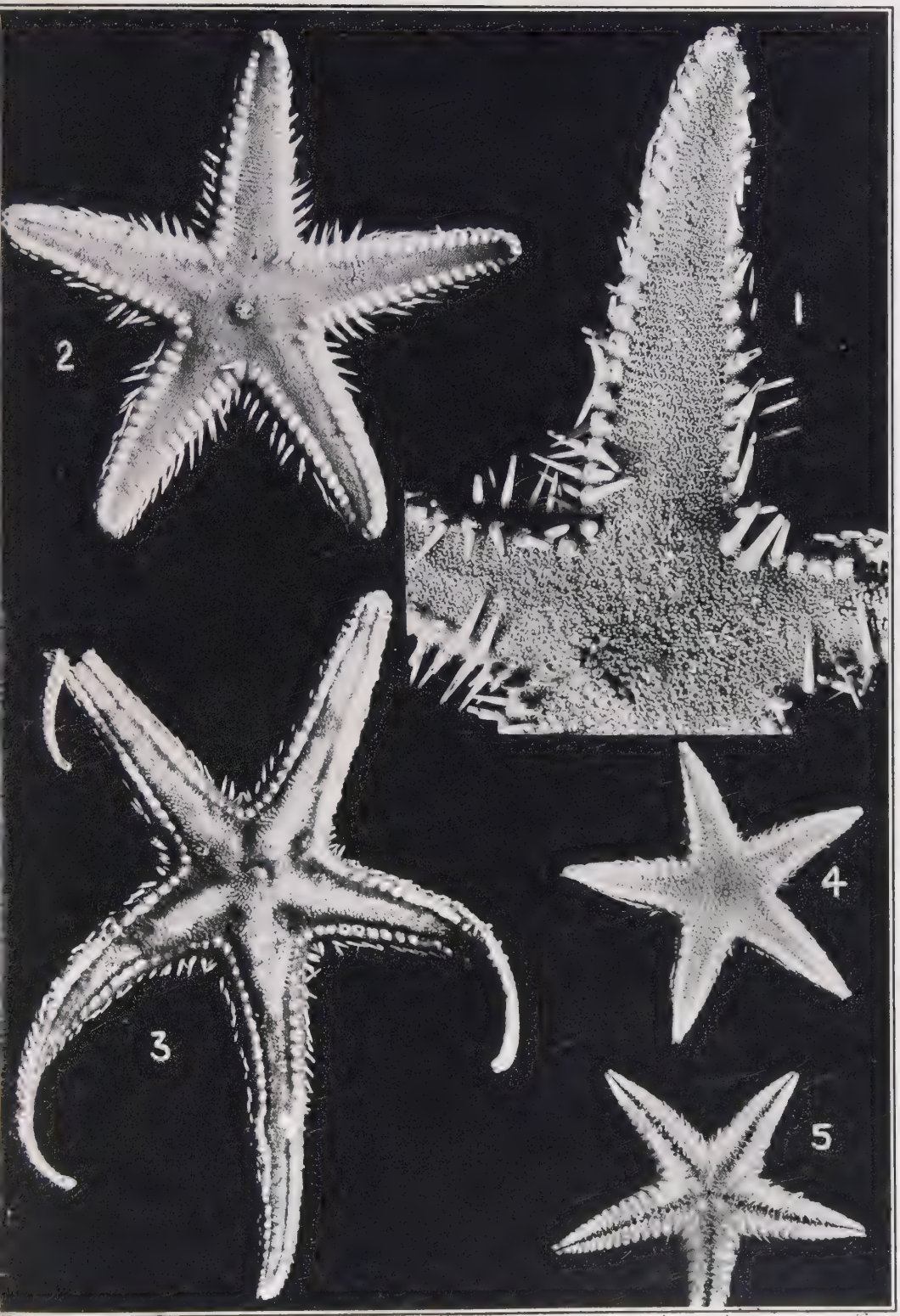
Fig. 2. *Brisinga evermanni.* Adambulacral plates, 65 mm. from disk, × 4. 2*a*. Same from outer third of ray, × 4. The plates should be a trifle slenderer. 2*b*. Mouth plates, × 5. First adambulacrals are also shown in center. 2*c*. Pedicellaria from adambulacral spine.

Fig. 3. *Brisinga fragilis.* Side of ray, 35 mm. from disk, × 4. 3*a*. Mouth plates and first adambulacral plates, × 5. The single plate to the left represents "variation *a*," those in center the type, and that on right "variation *d*," which has a very thick sacculus on the marginal spines. 3*b*. Adambulacral plates, 50 mm. from disk, × 5. 3*c*. Pedicellaria from one of the long adambulacral spines.

PLATE XLIX.

Fig. 1. *Antheniaster epixanthus.* Abactinal view of short-rayed specimen. Note two parasitic gastropods, one near madreporic body.

Figs. 2 and 3. *Psilaster attenuatus,* showing growth stages. 2. Thick-rayed form from south coast of Oahu. 3. Typical form.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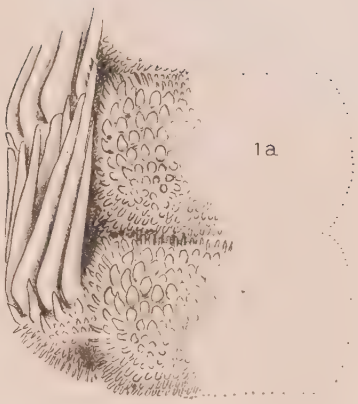
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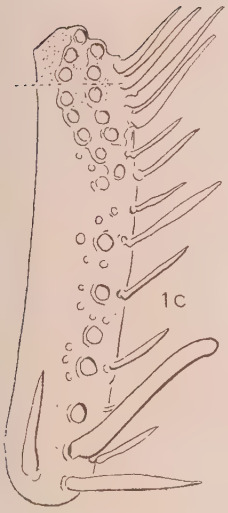
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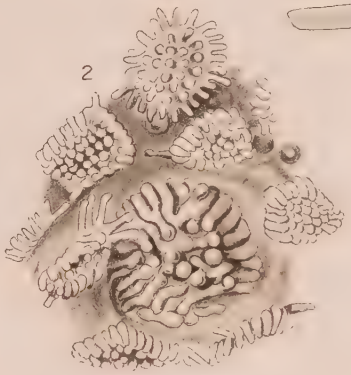
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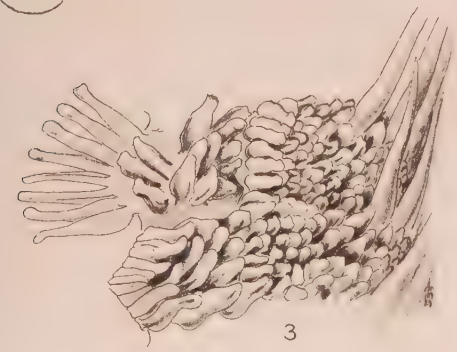
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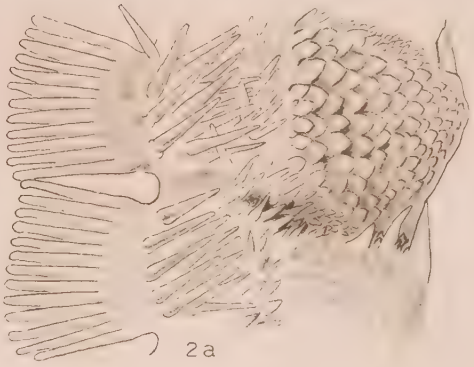
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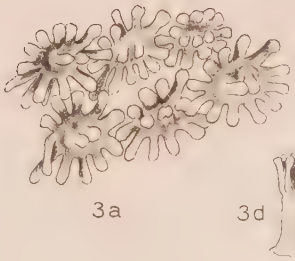
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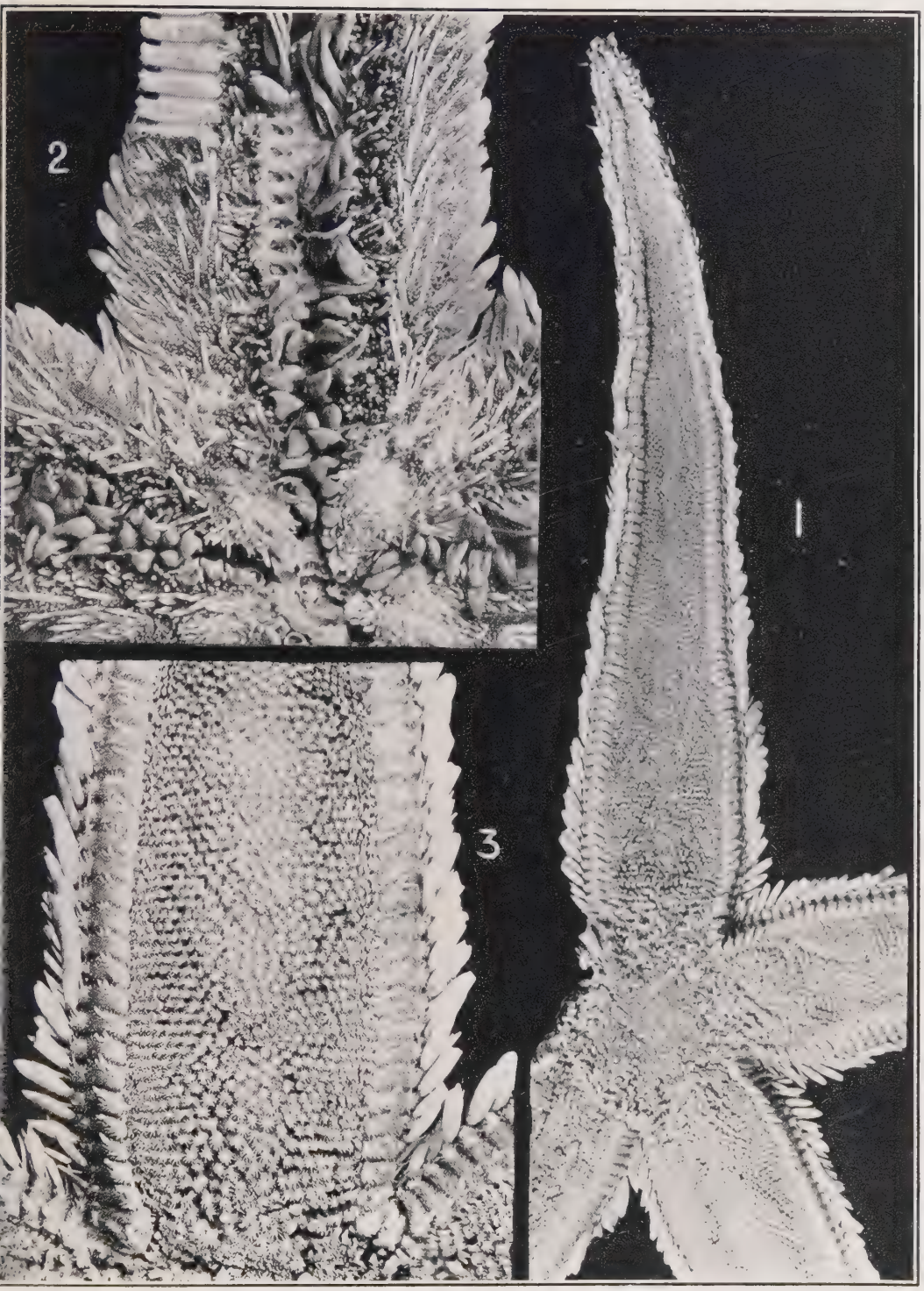
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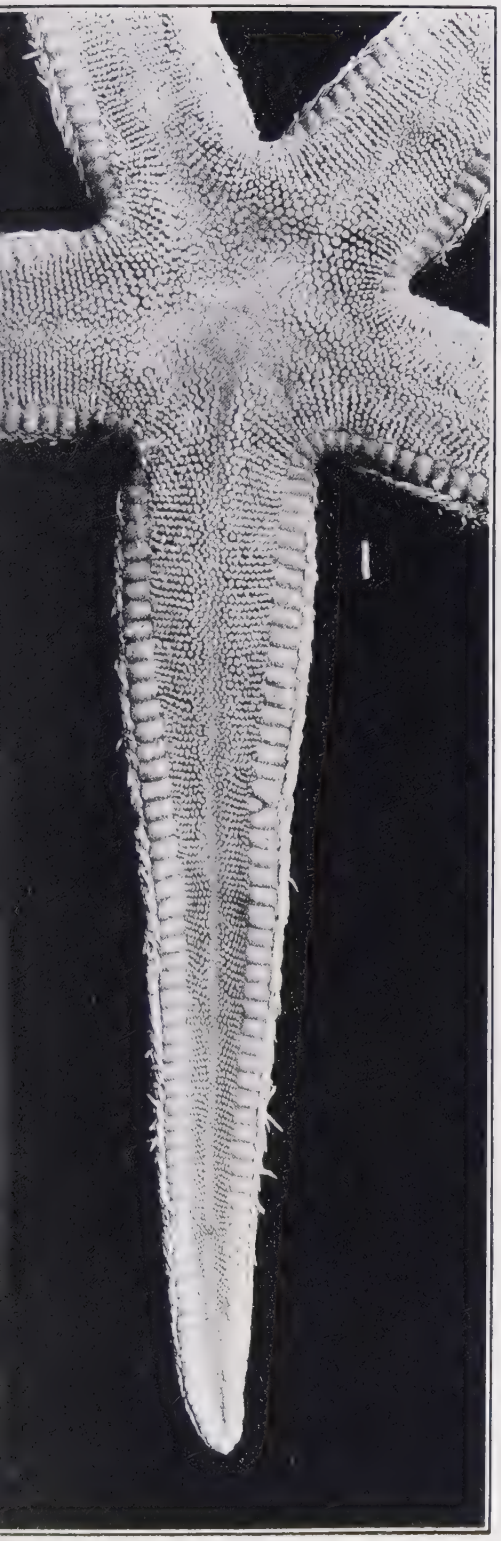
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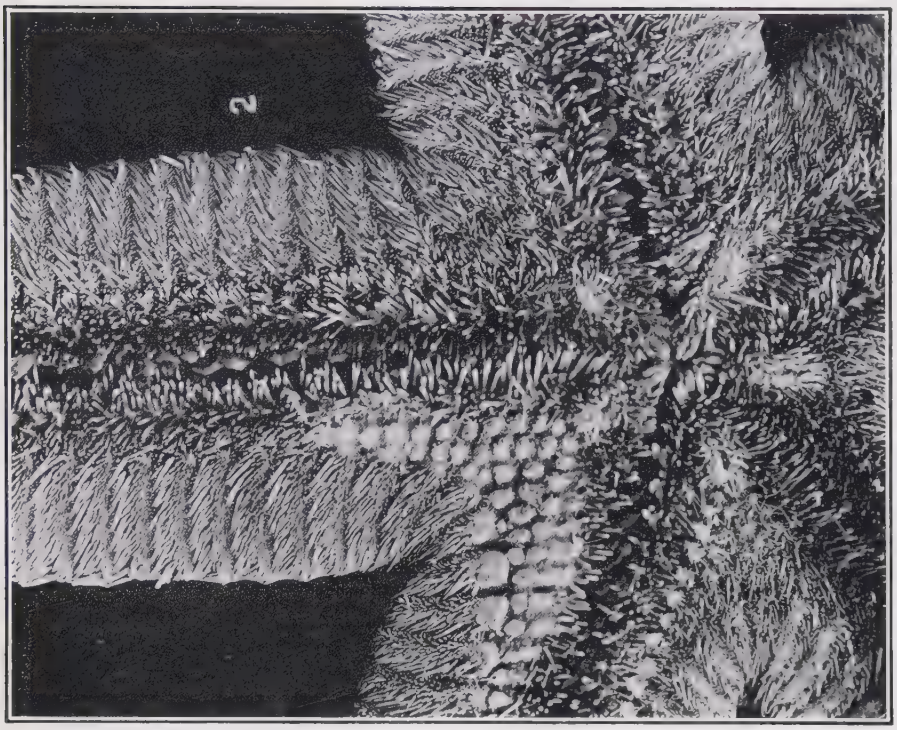

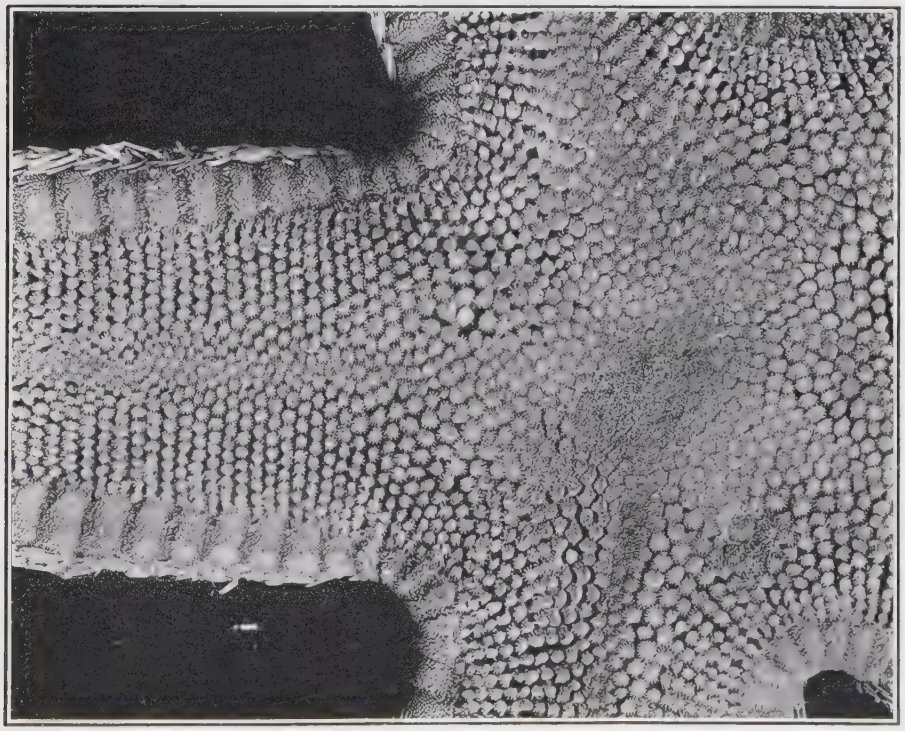

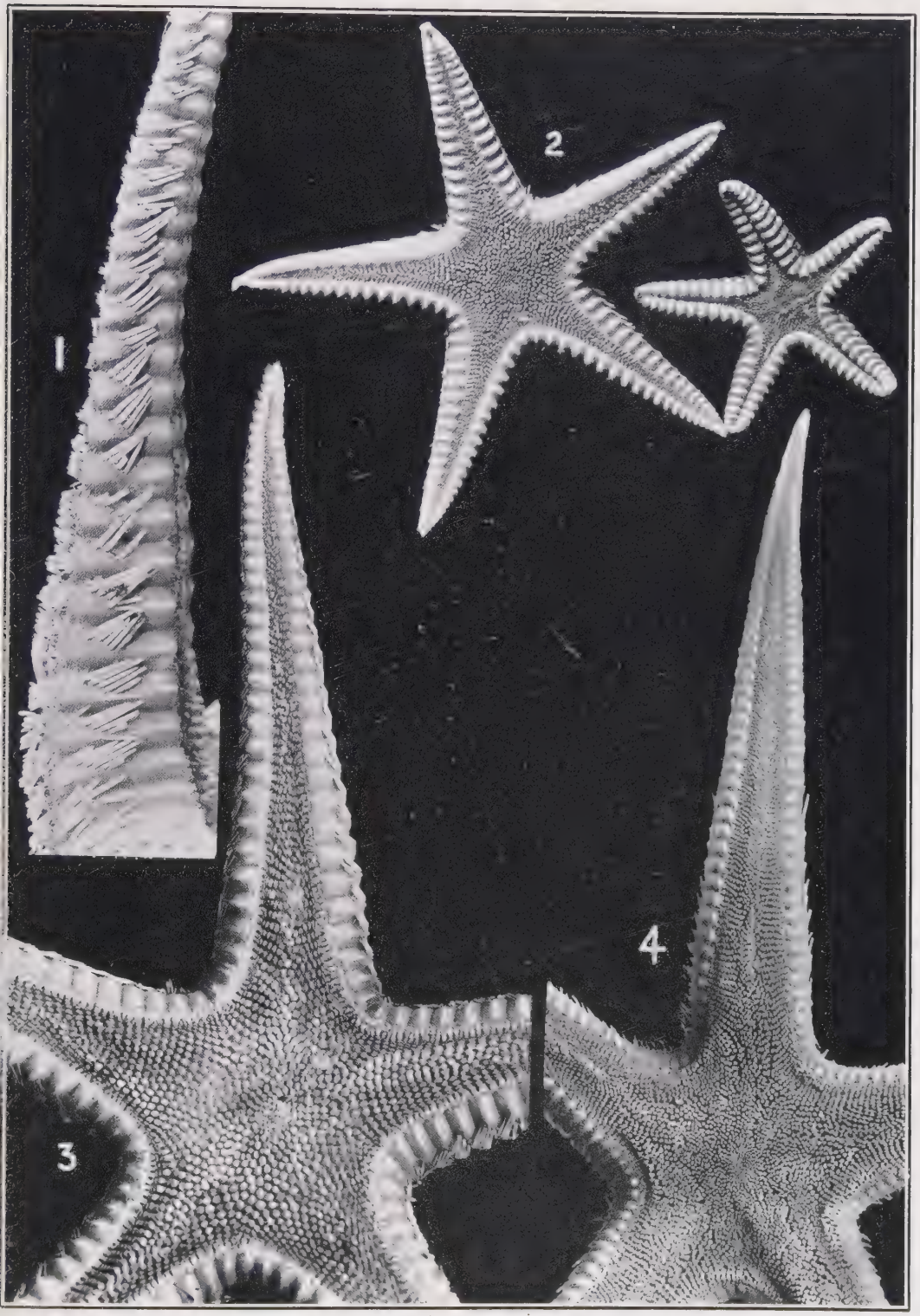
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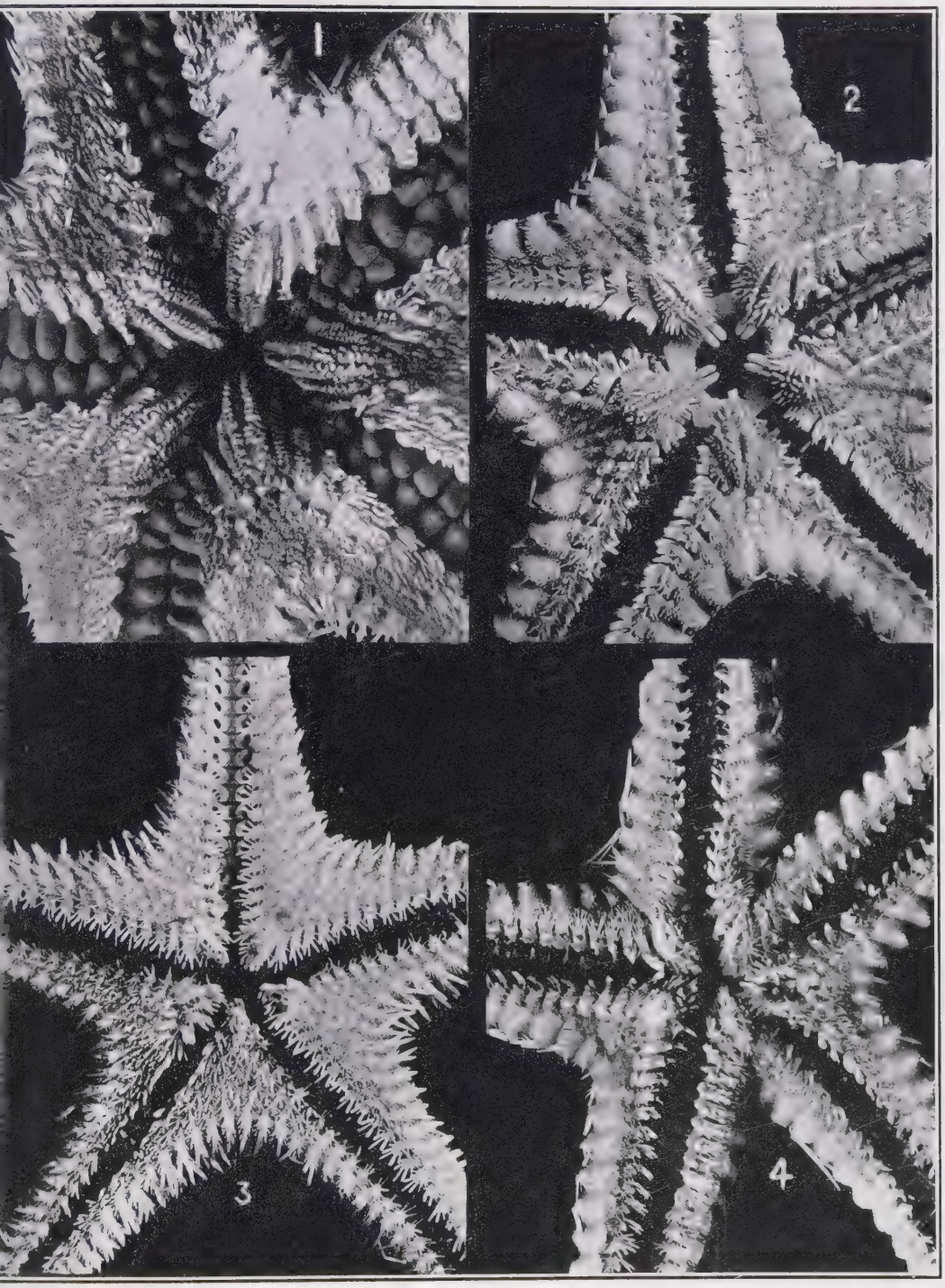
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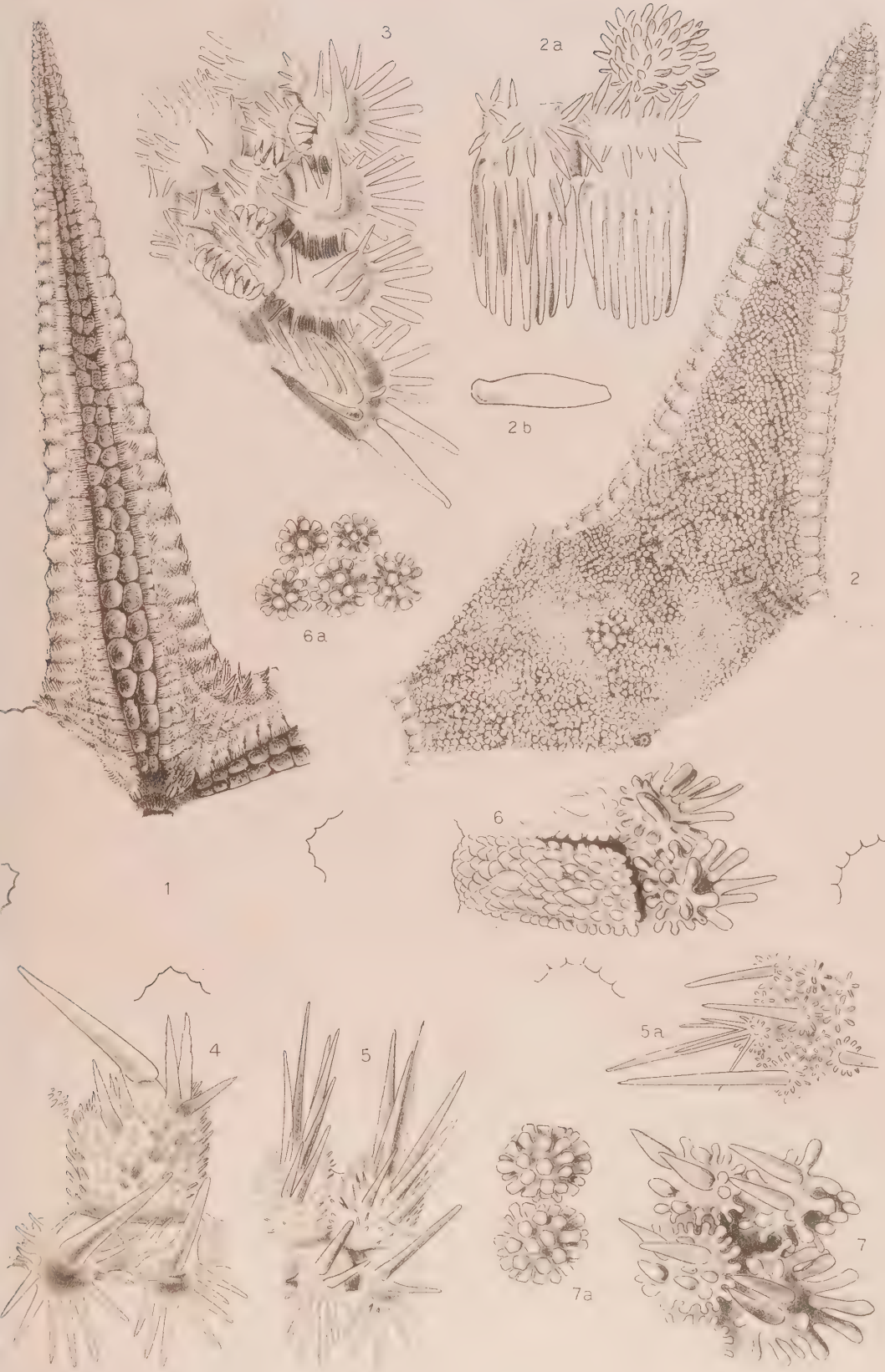
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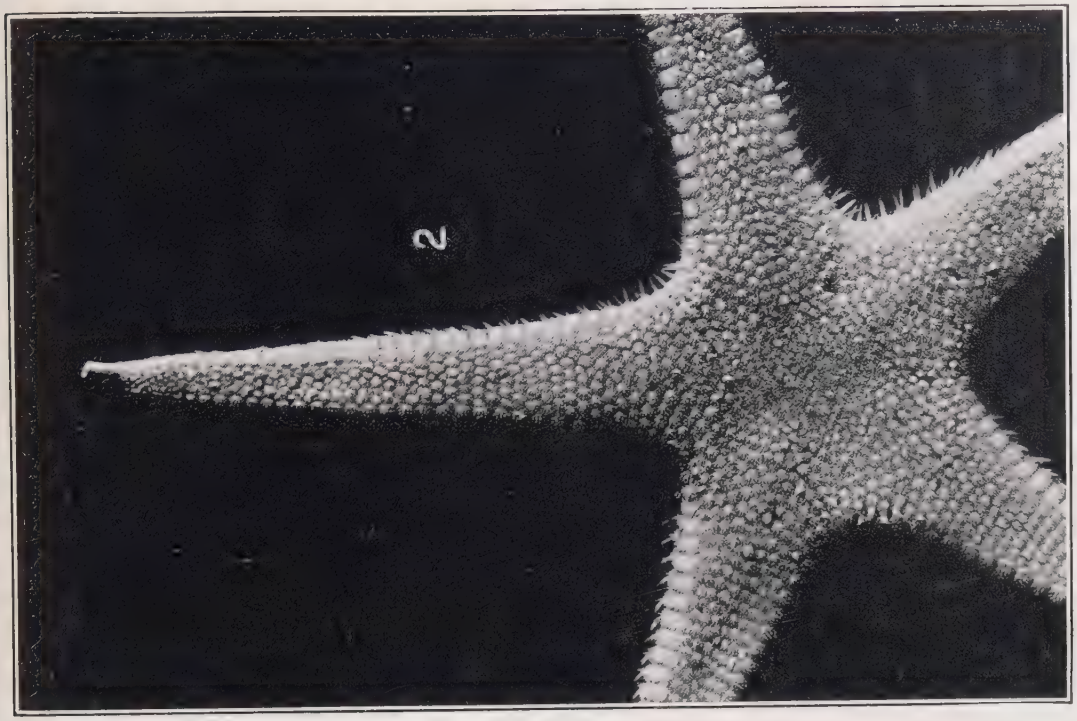

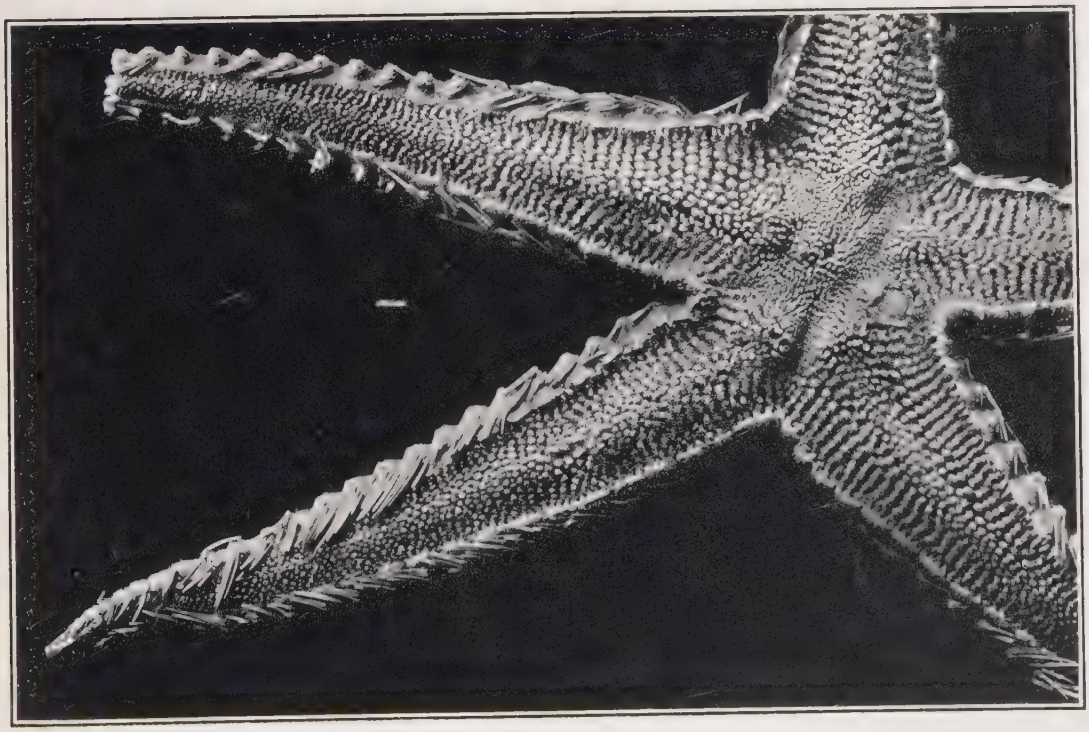

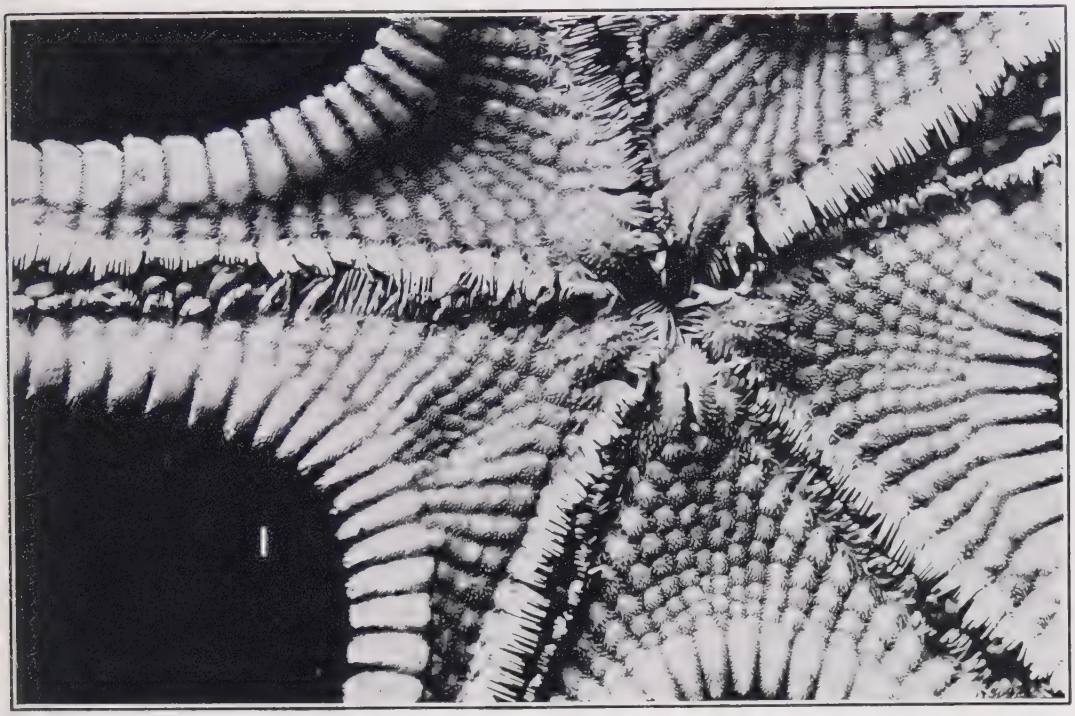
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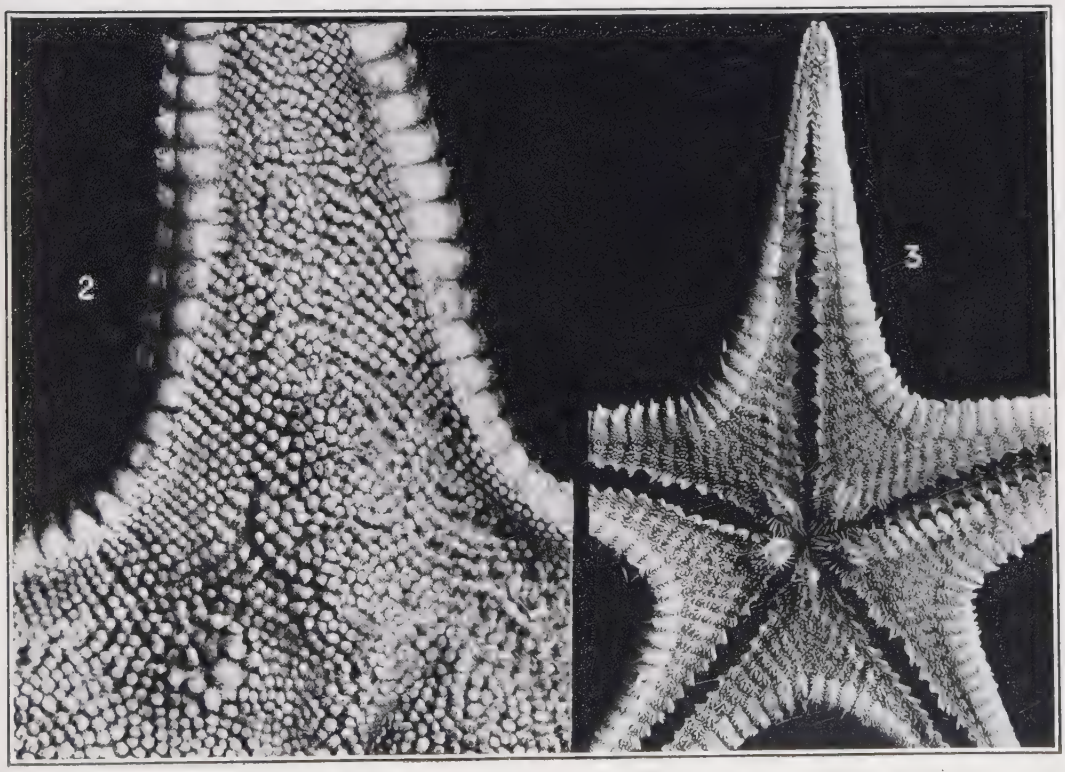
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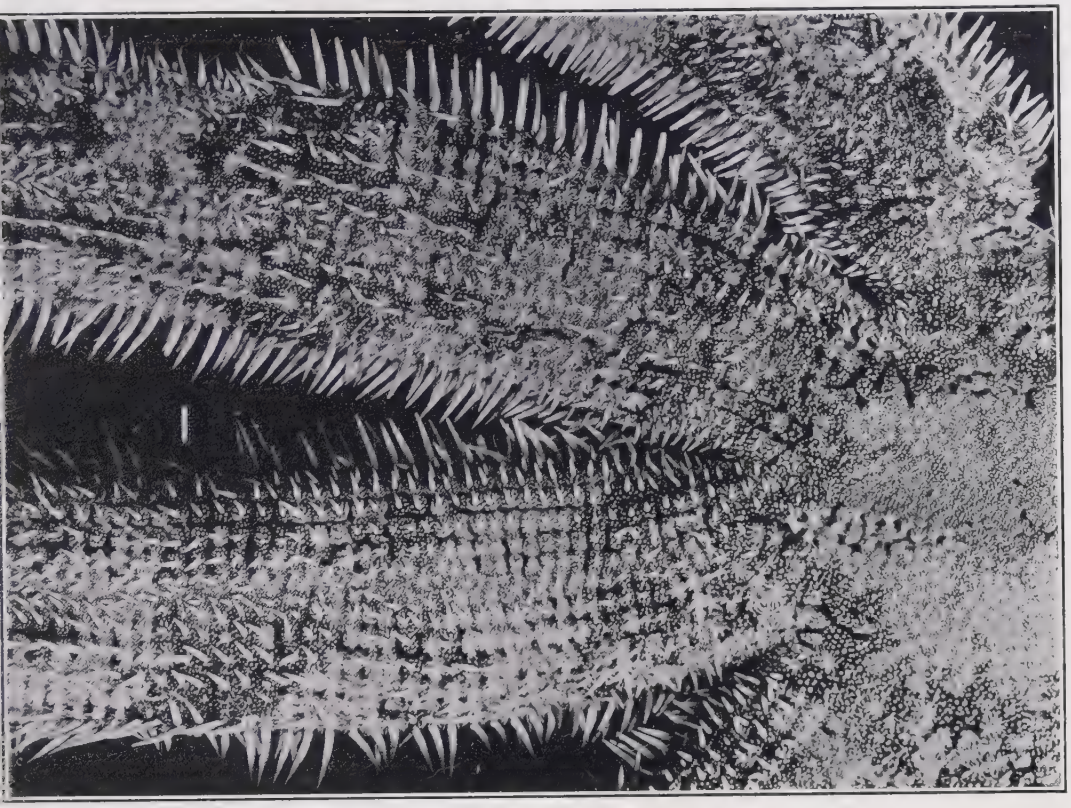
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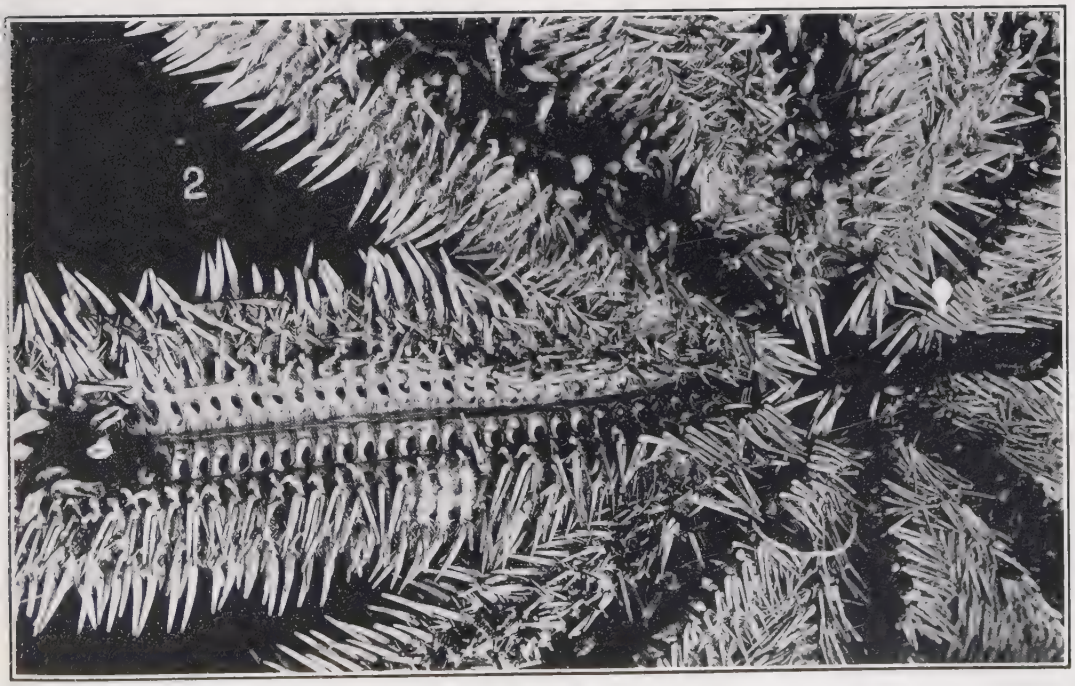
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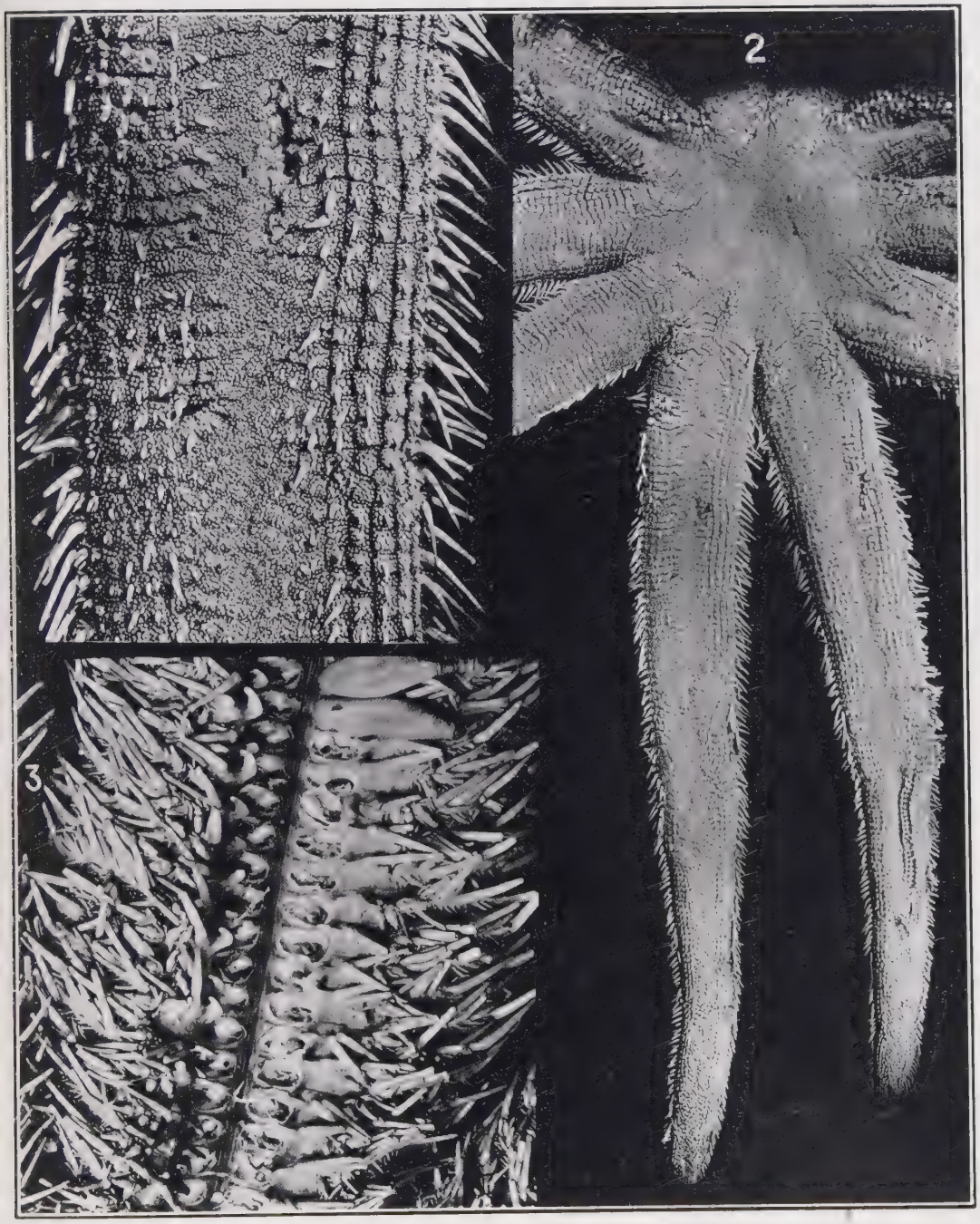
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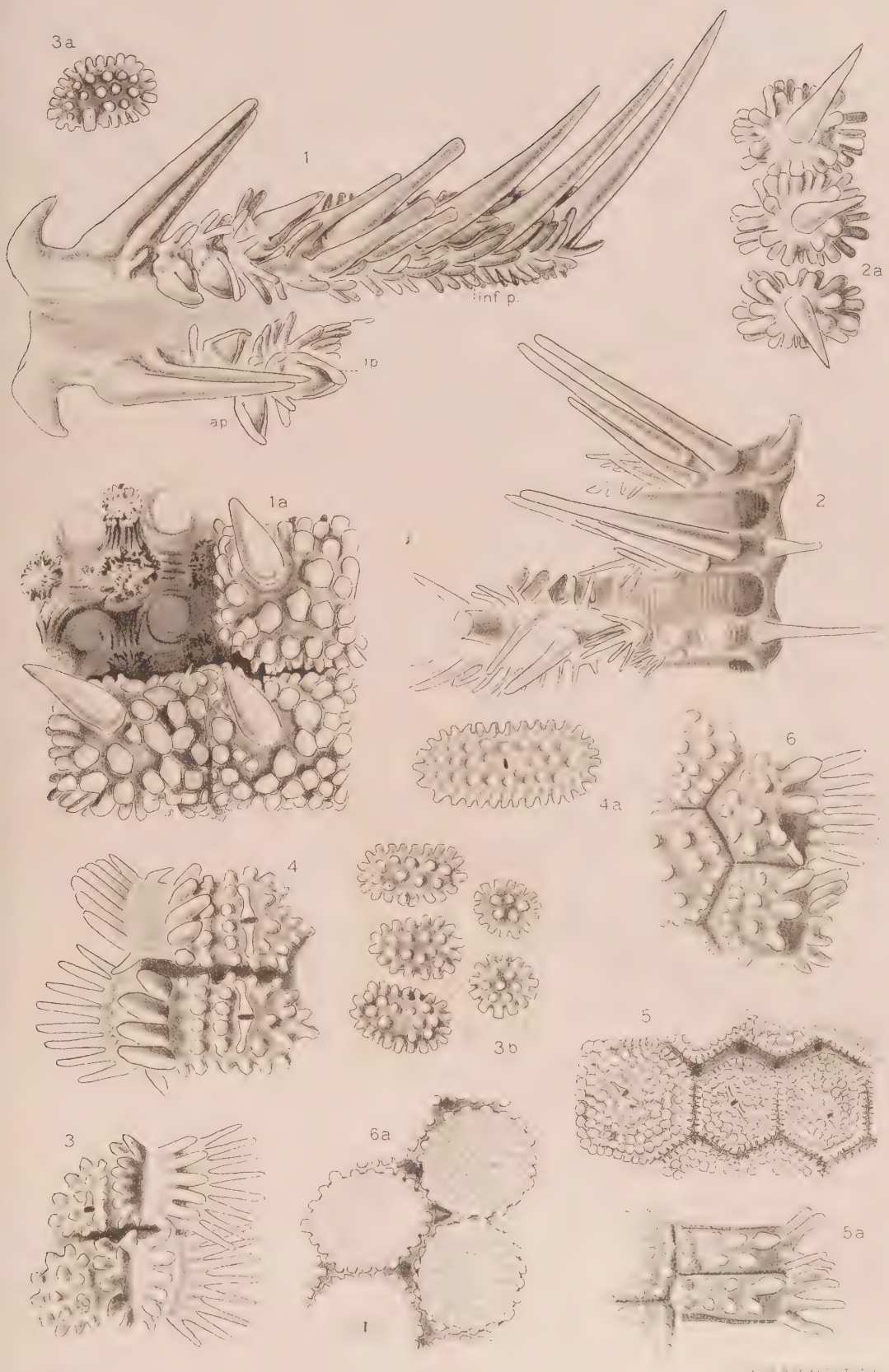

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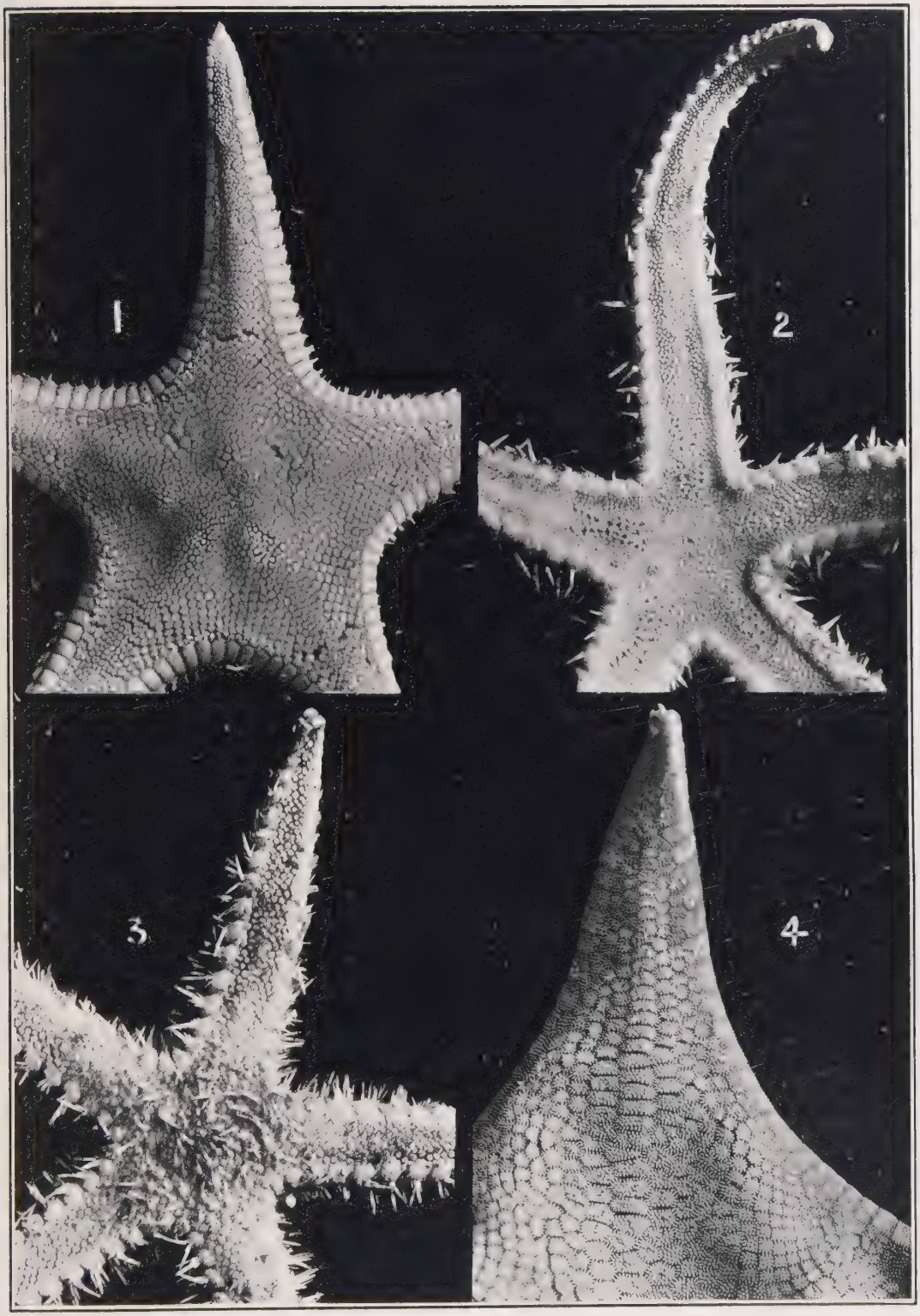
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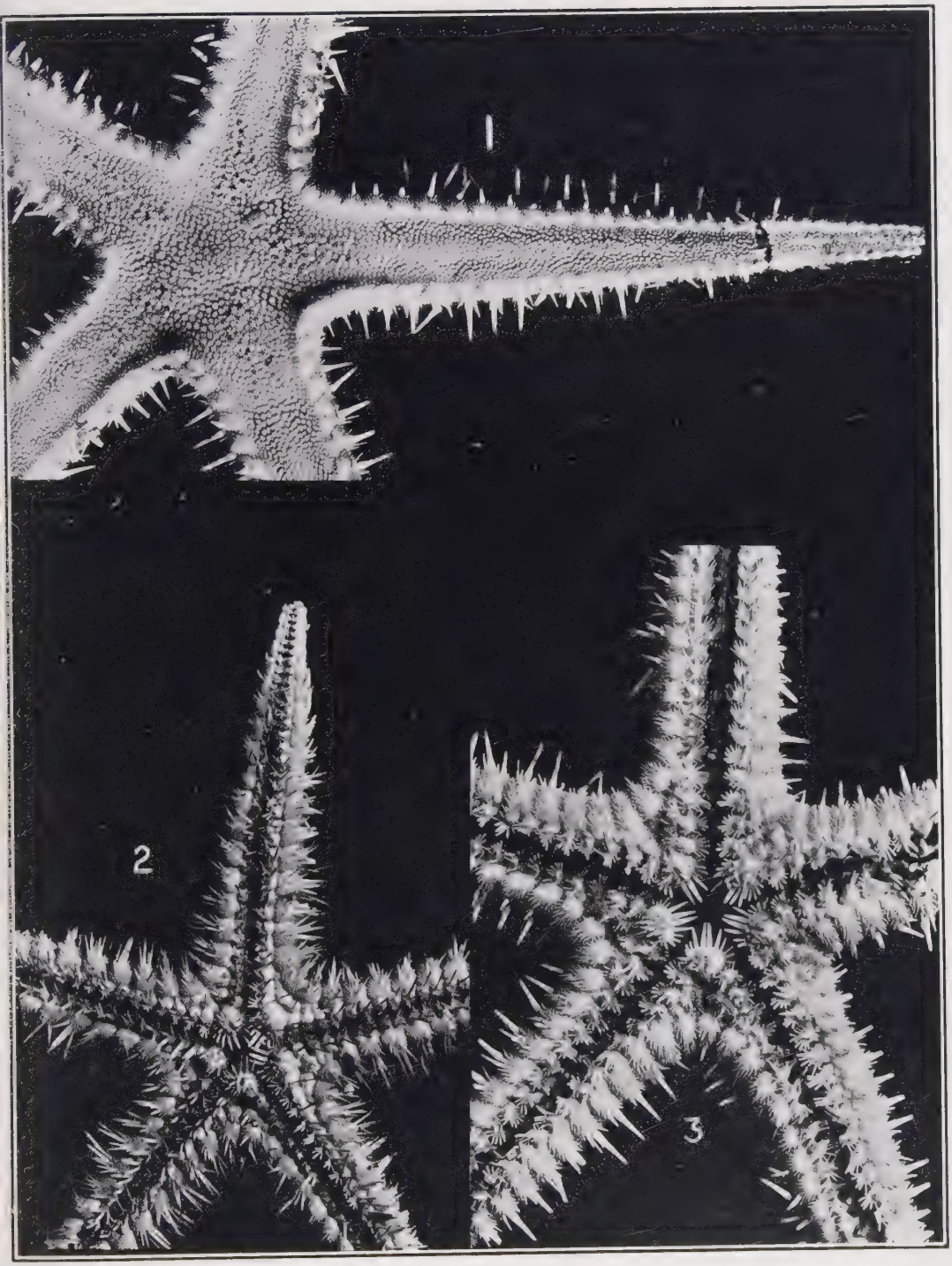
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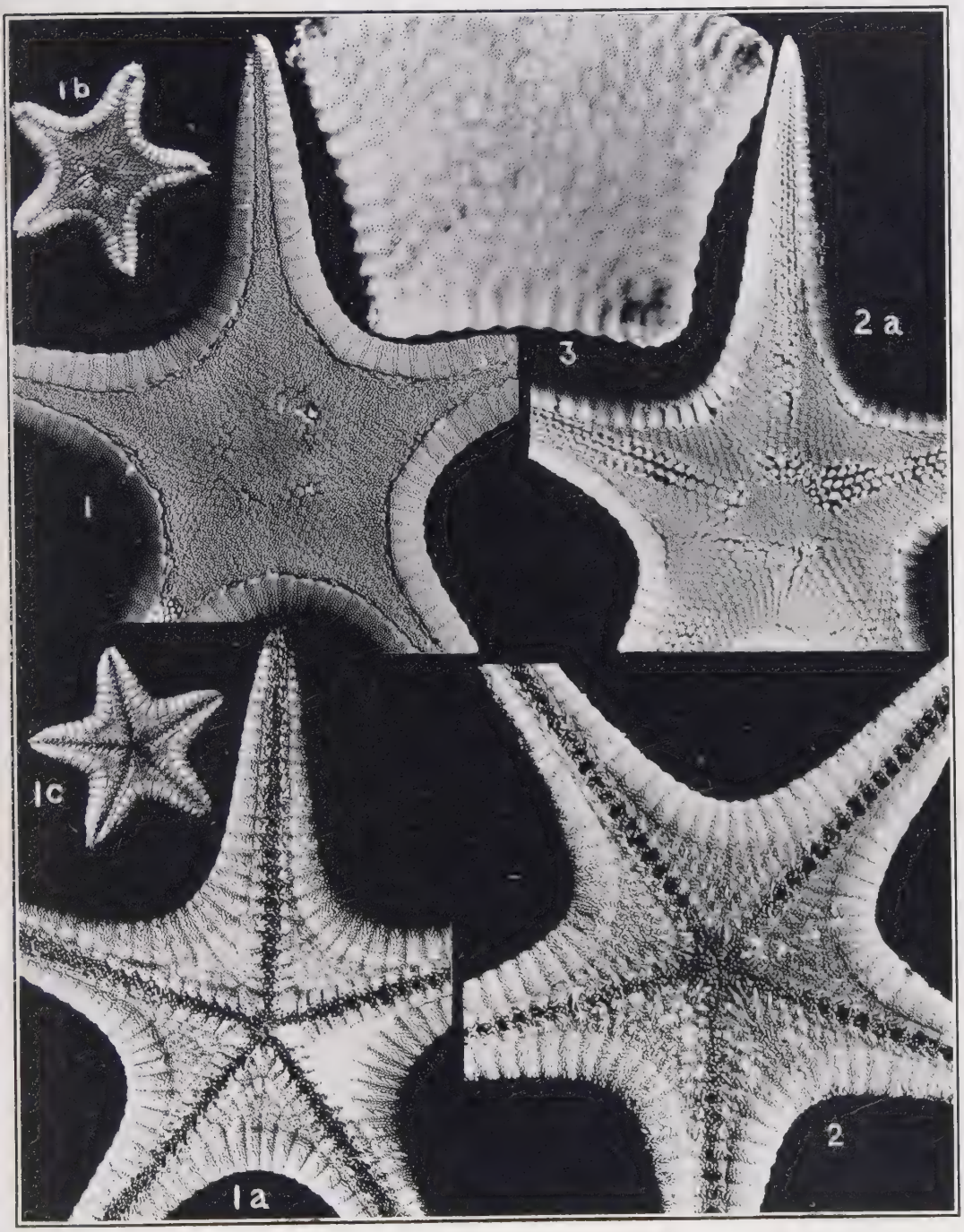
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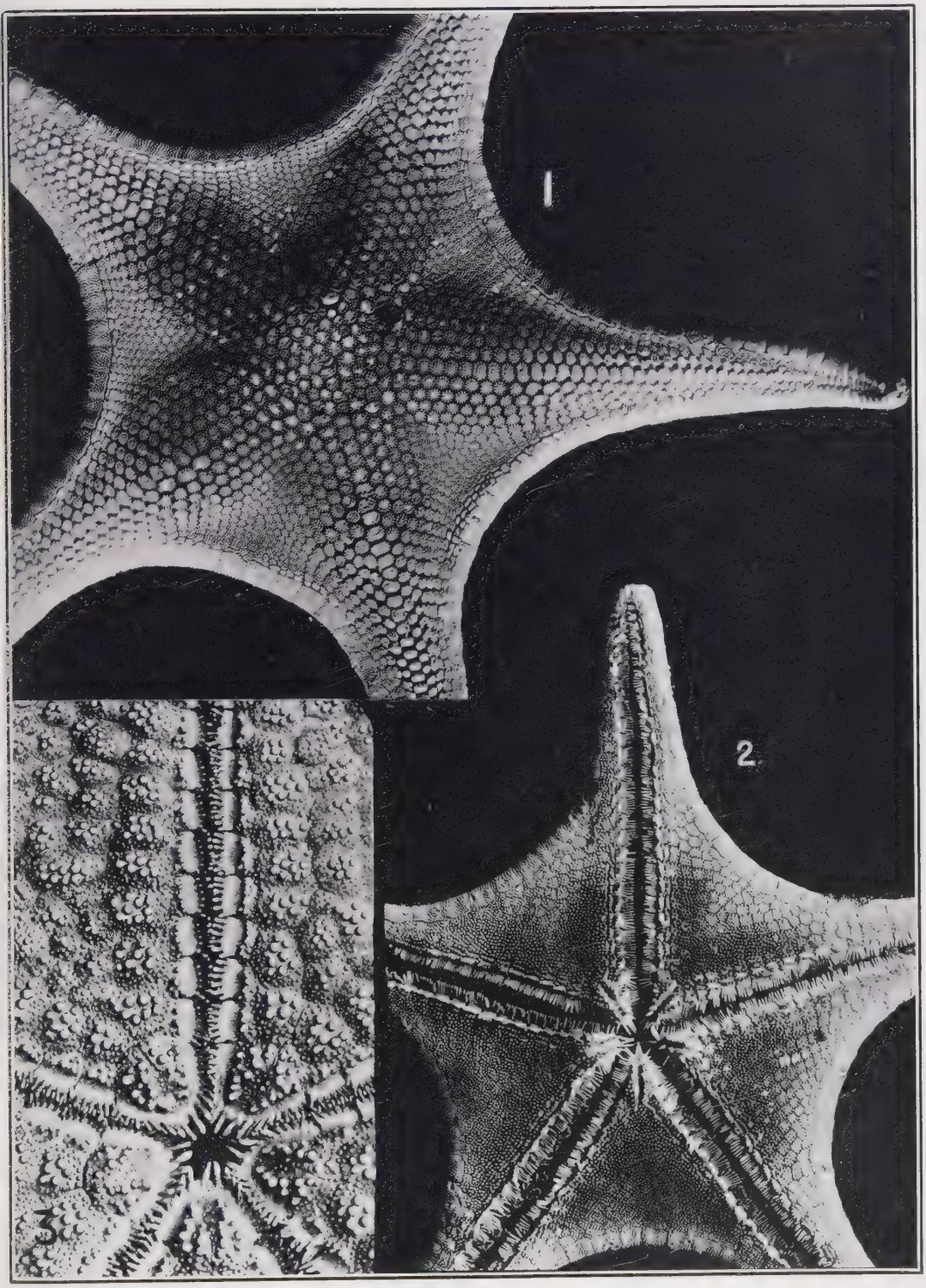
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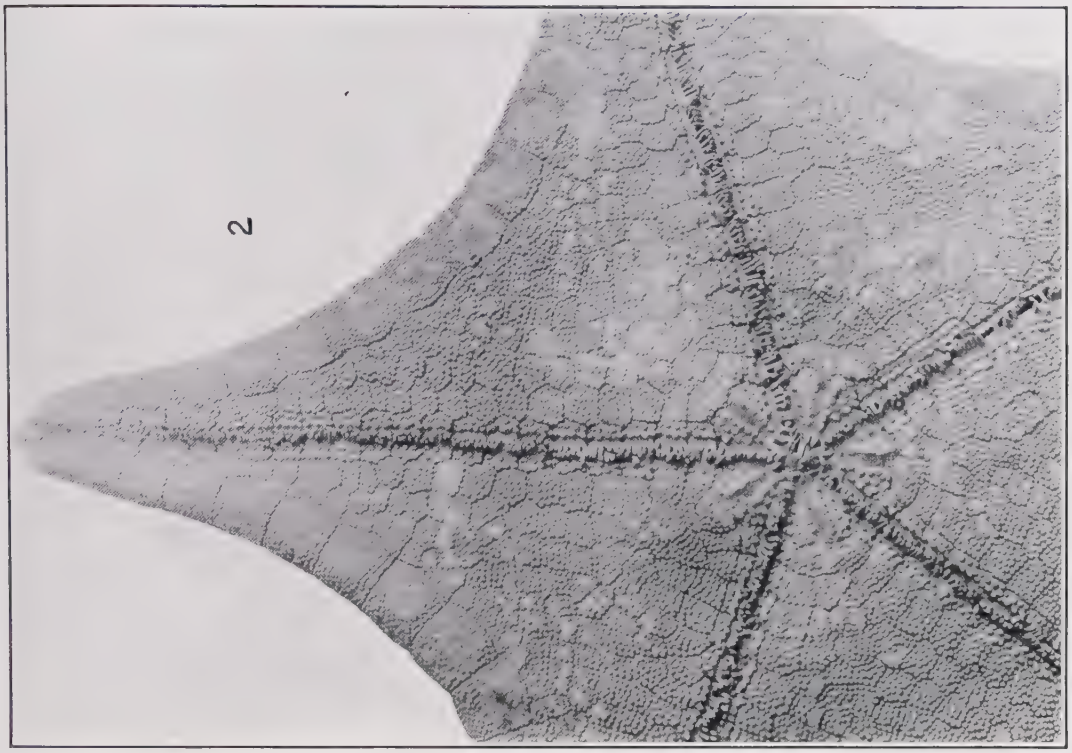
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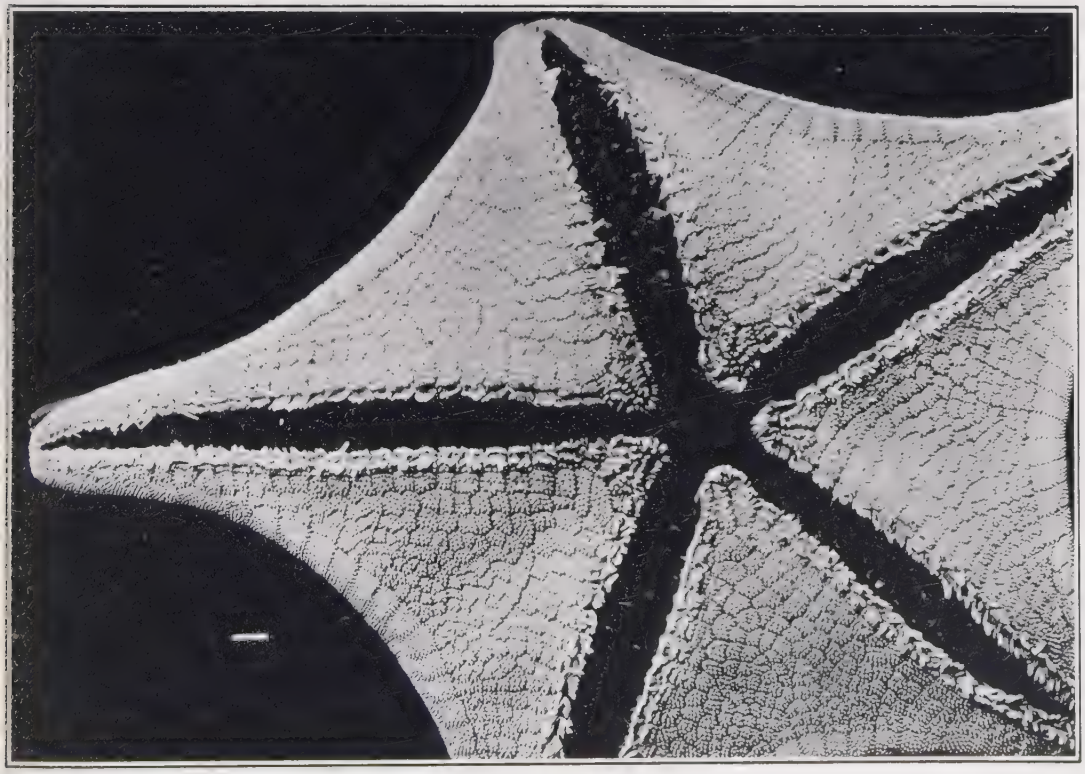

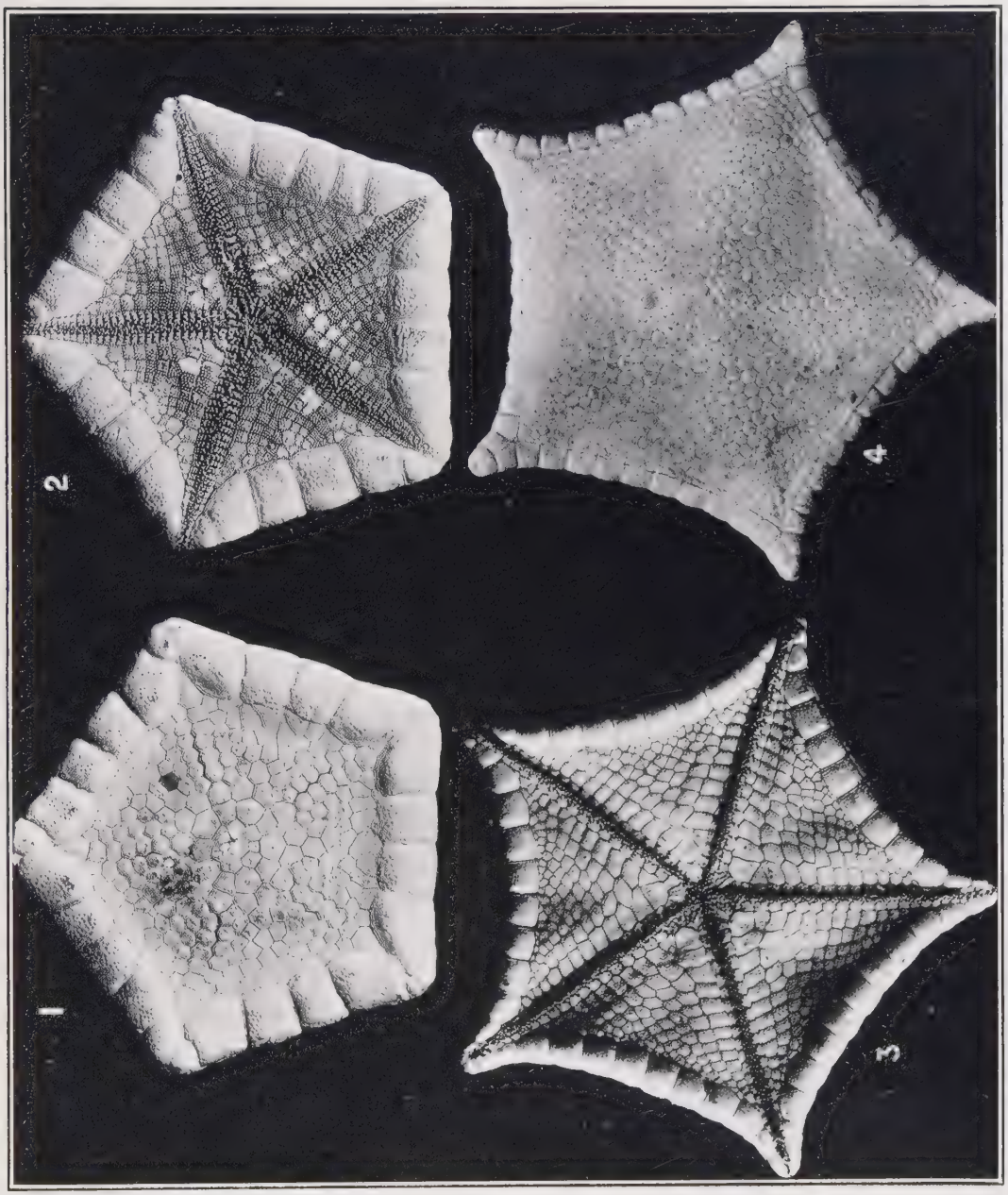
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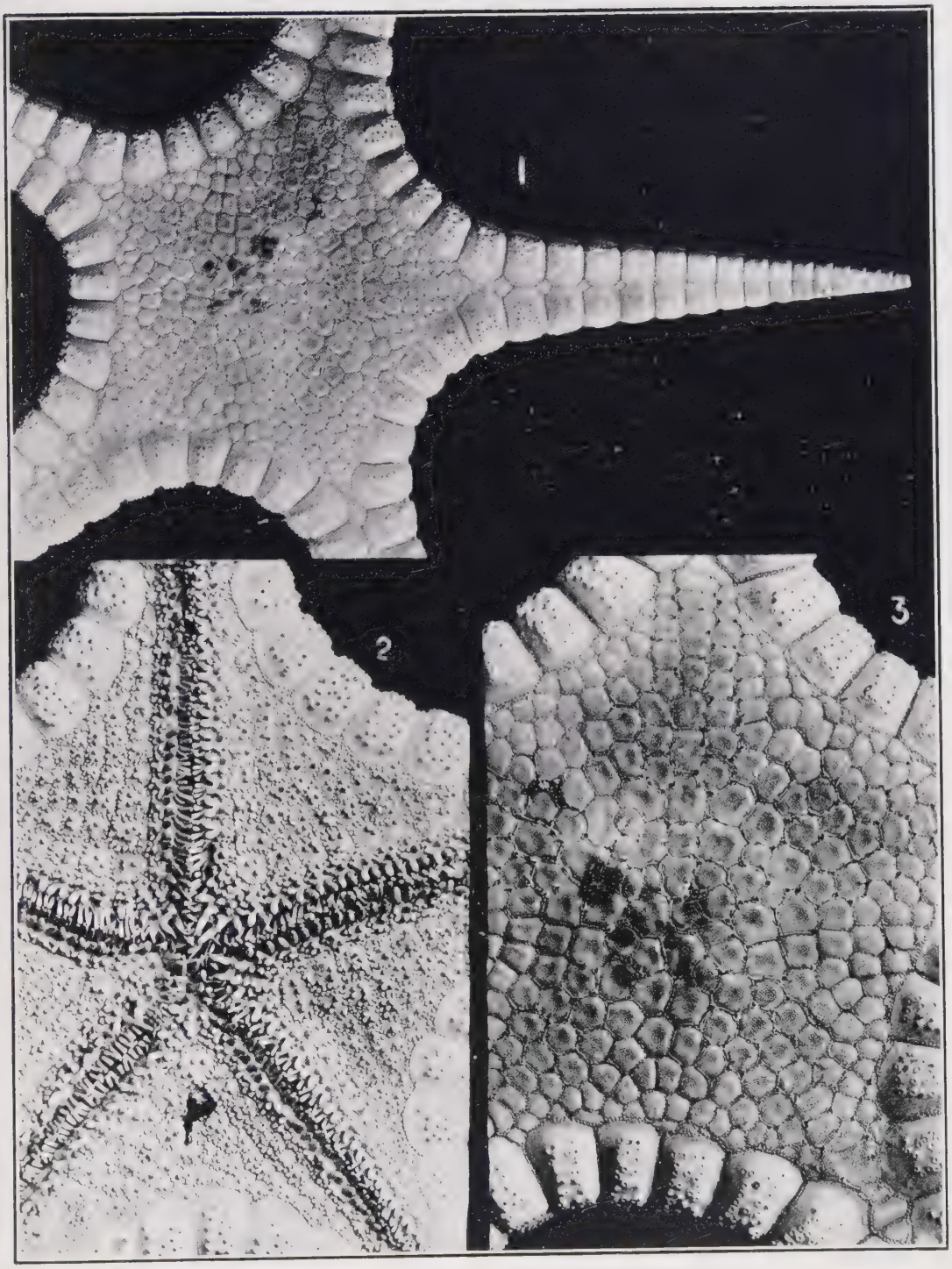
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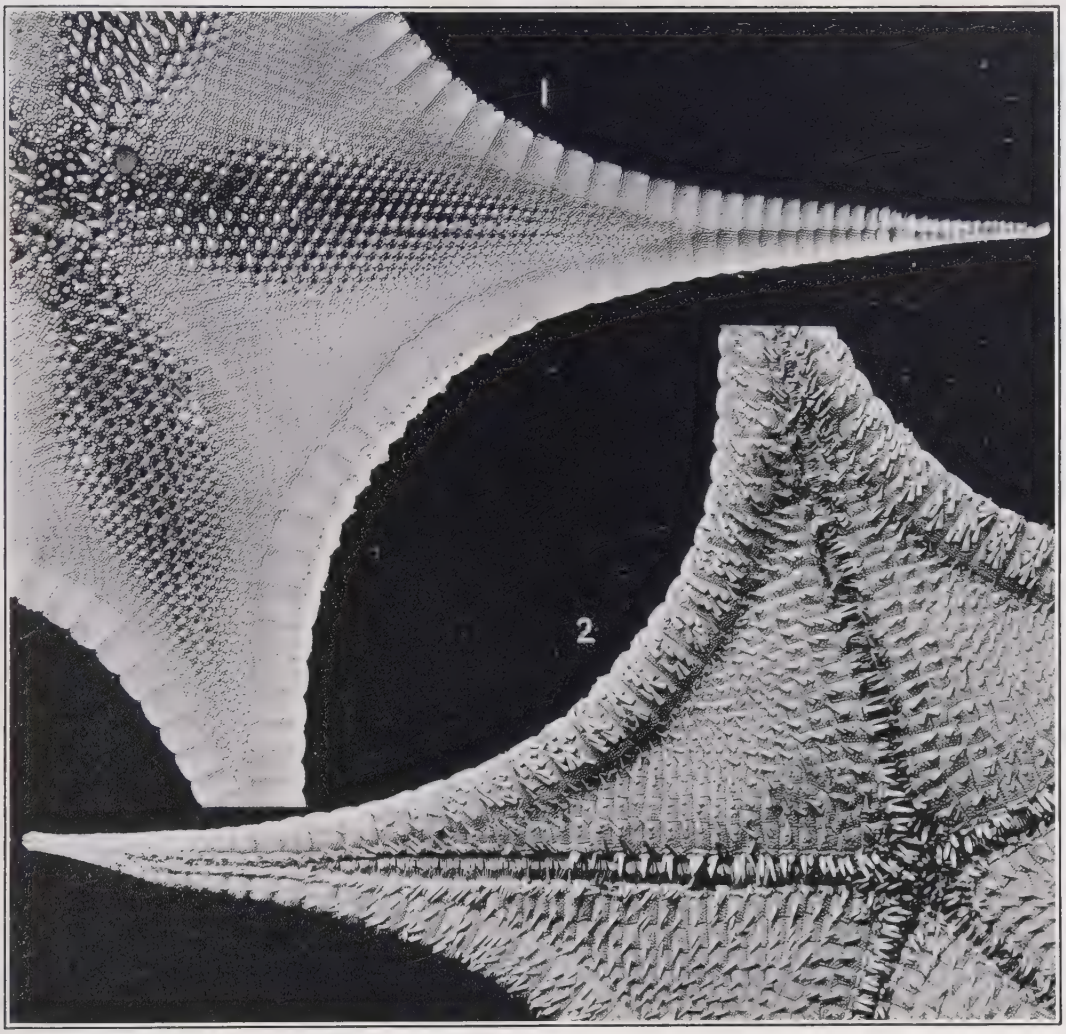
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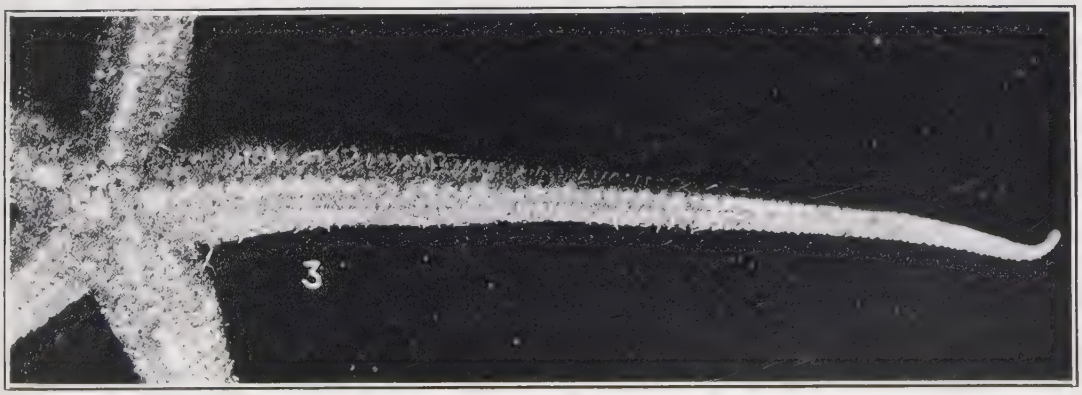
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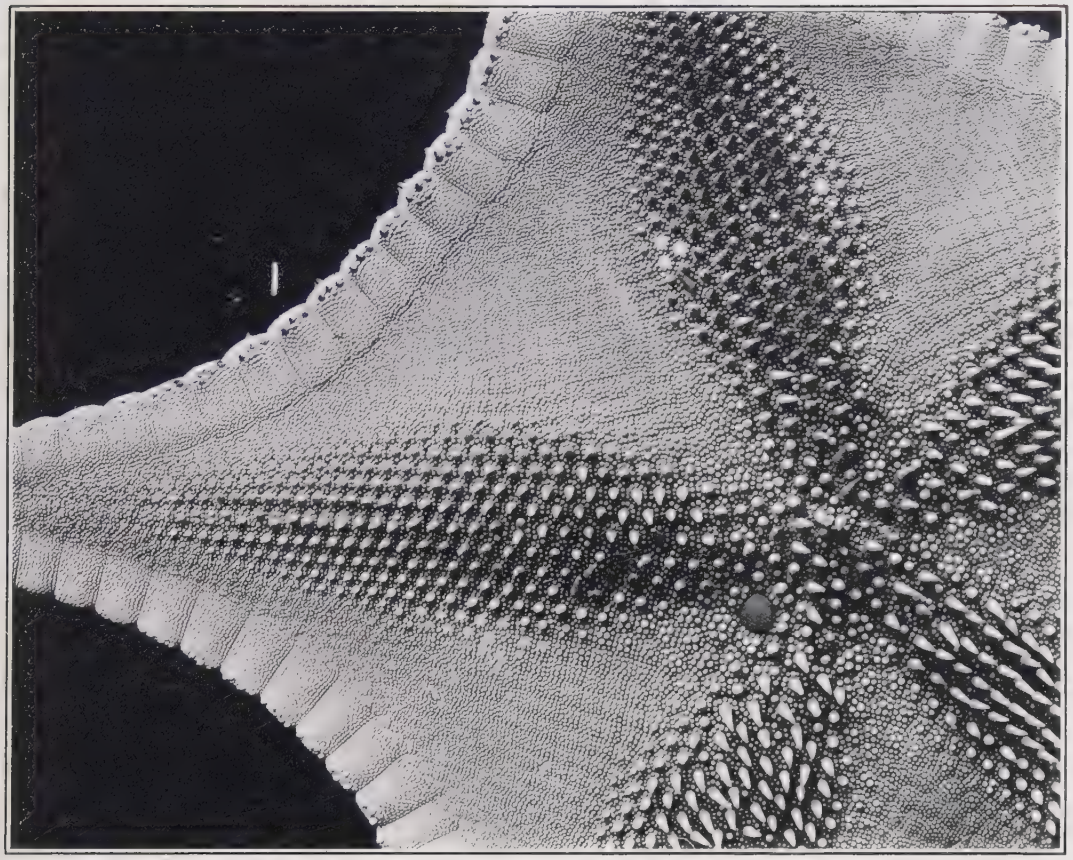
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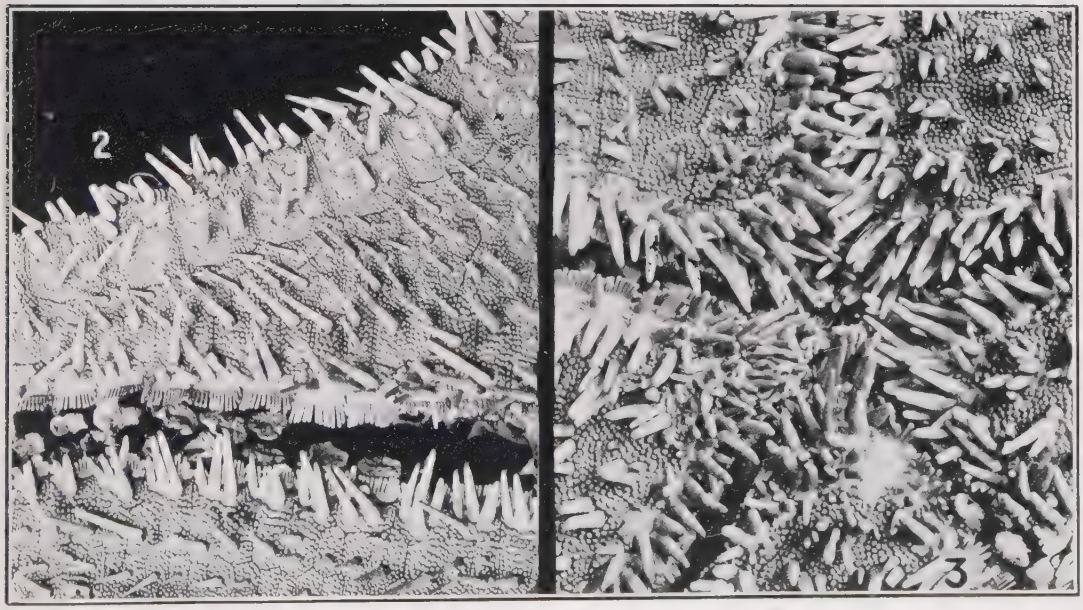
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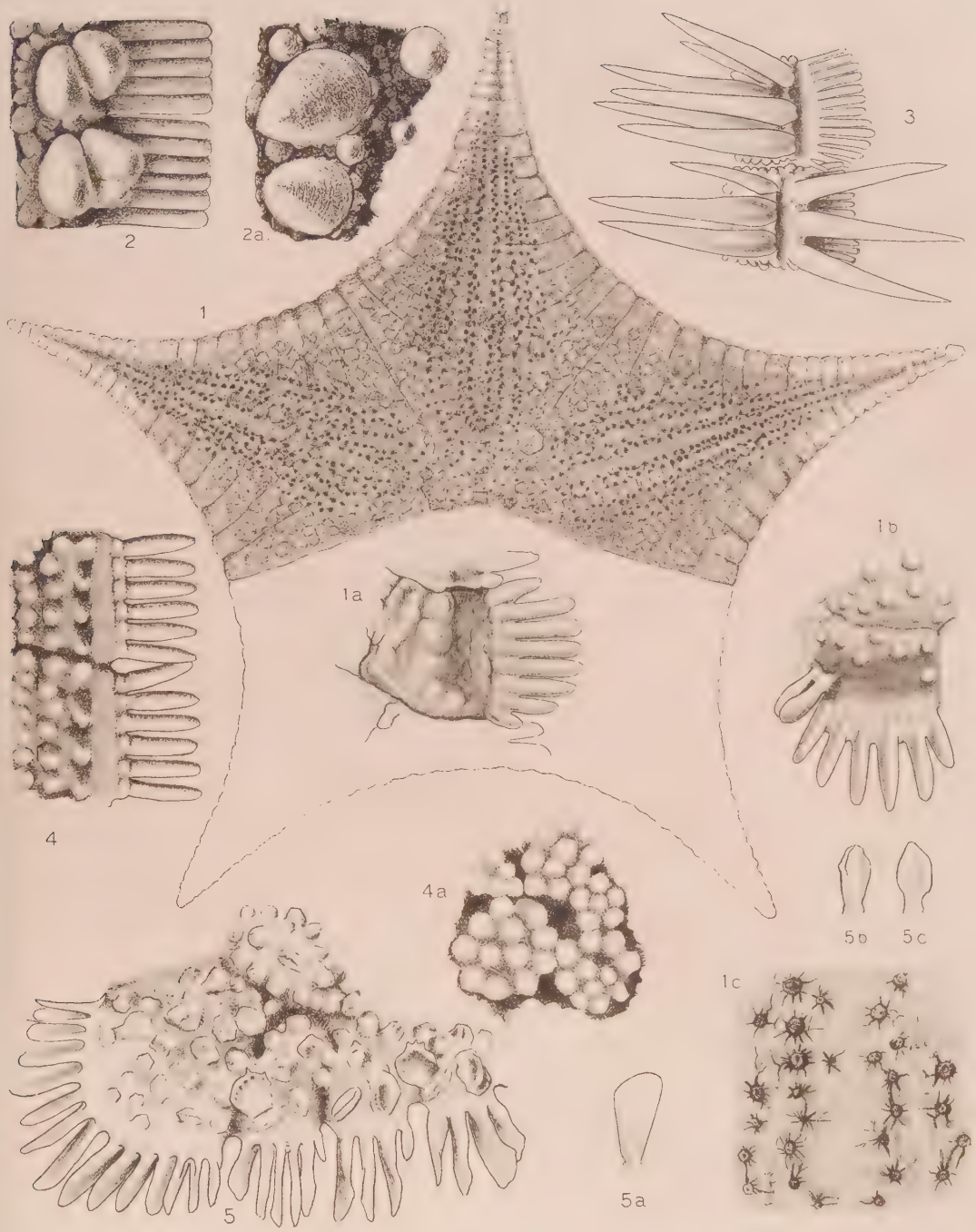
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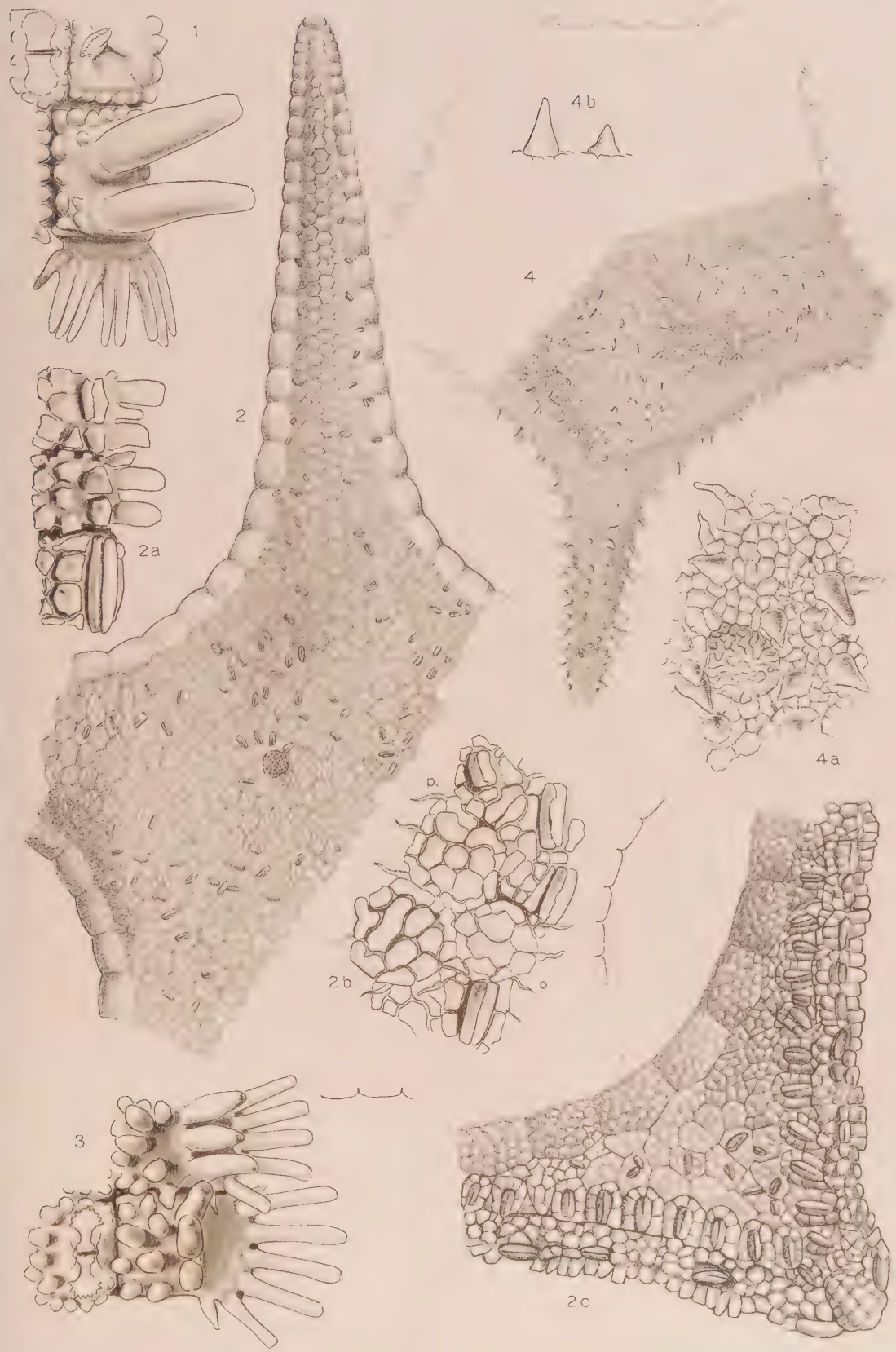

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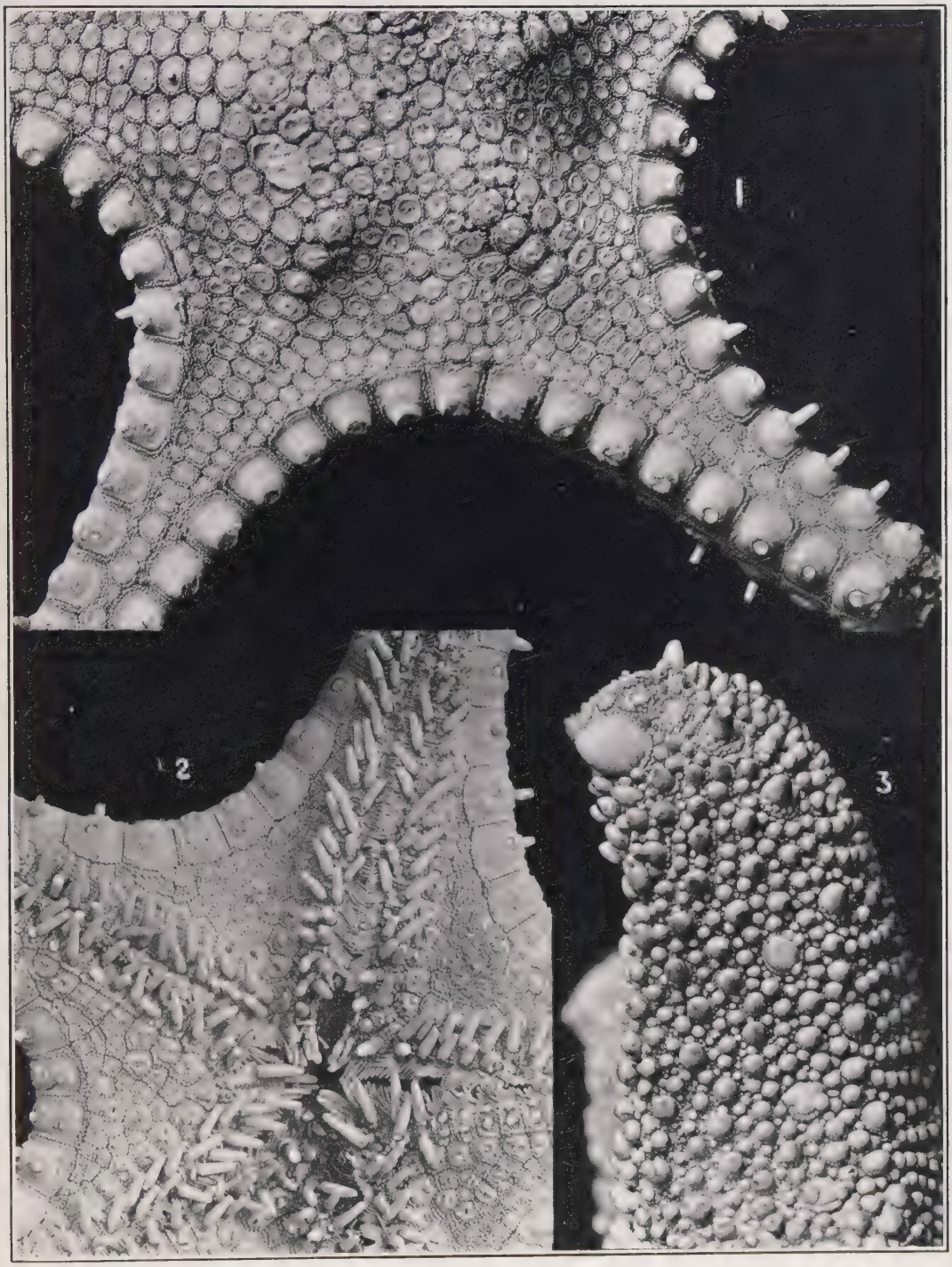
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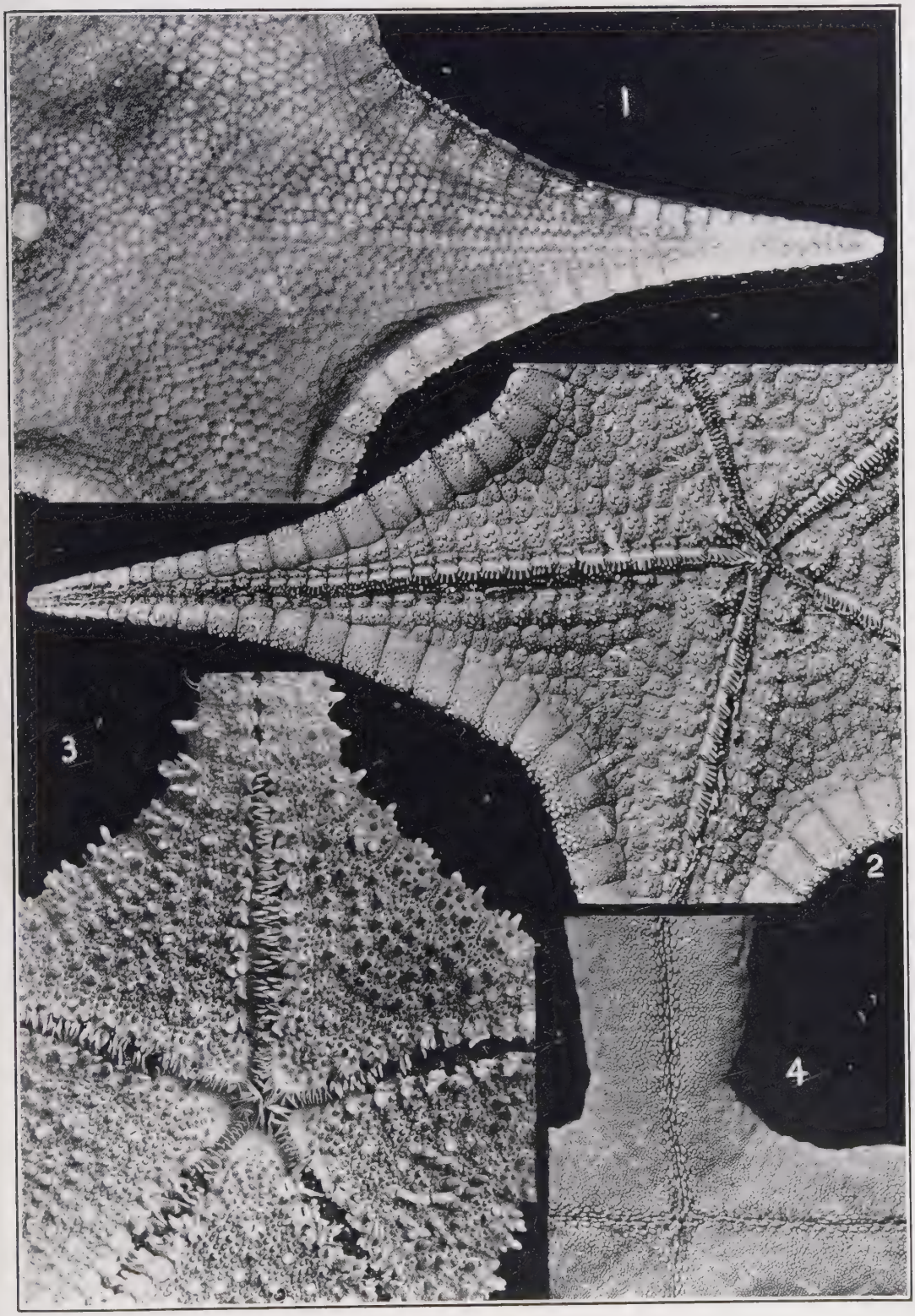
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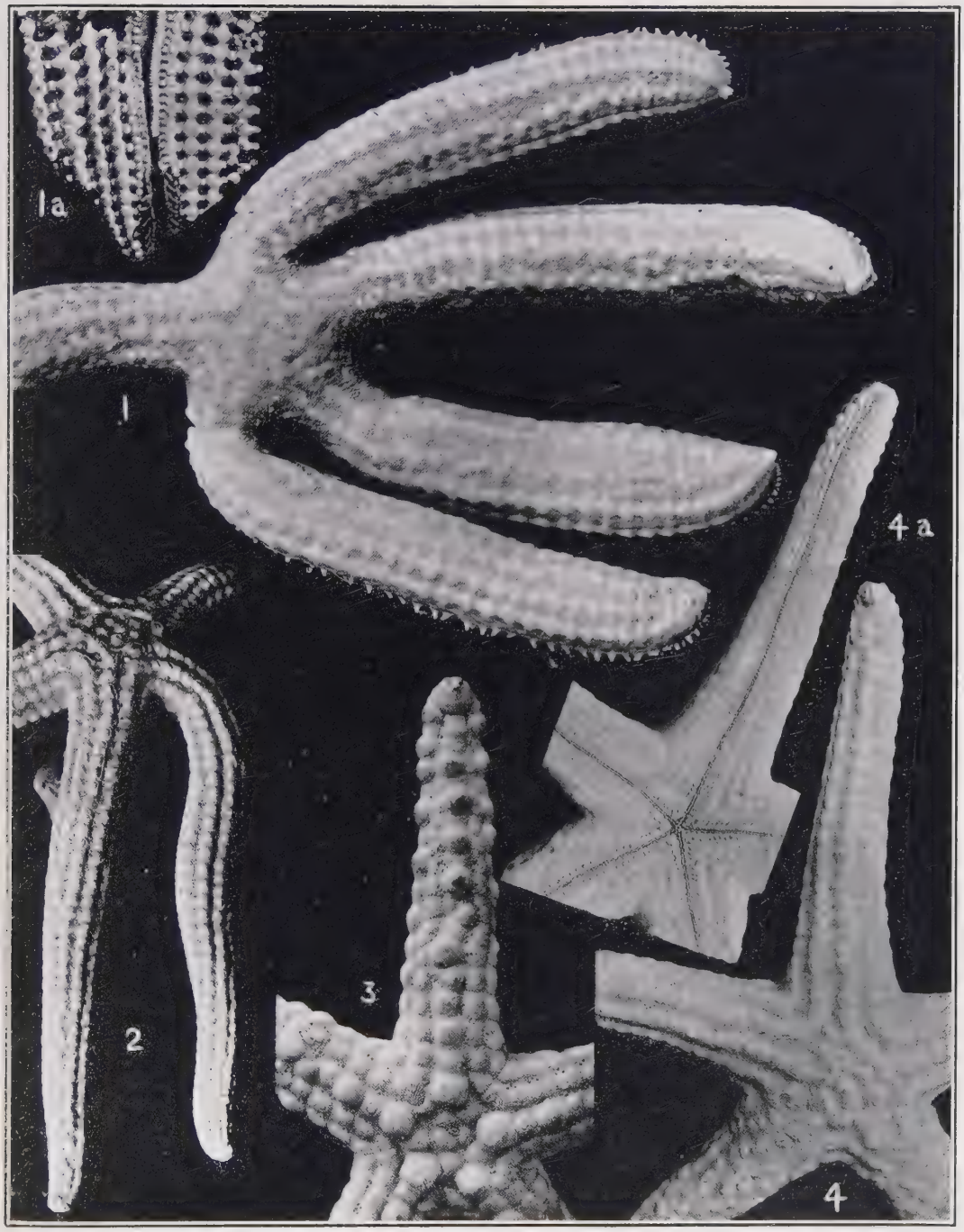
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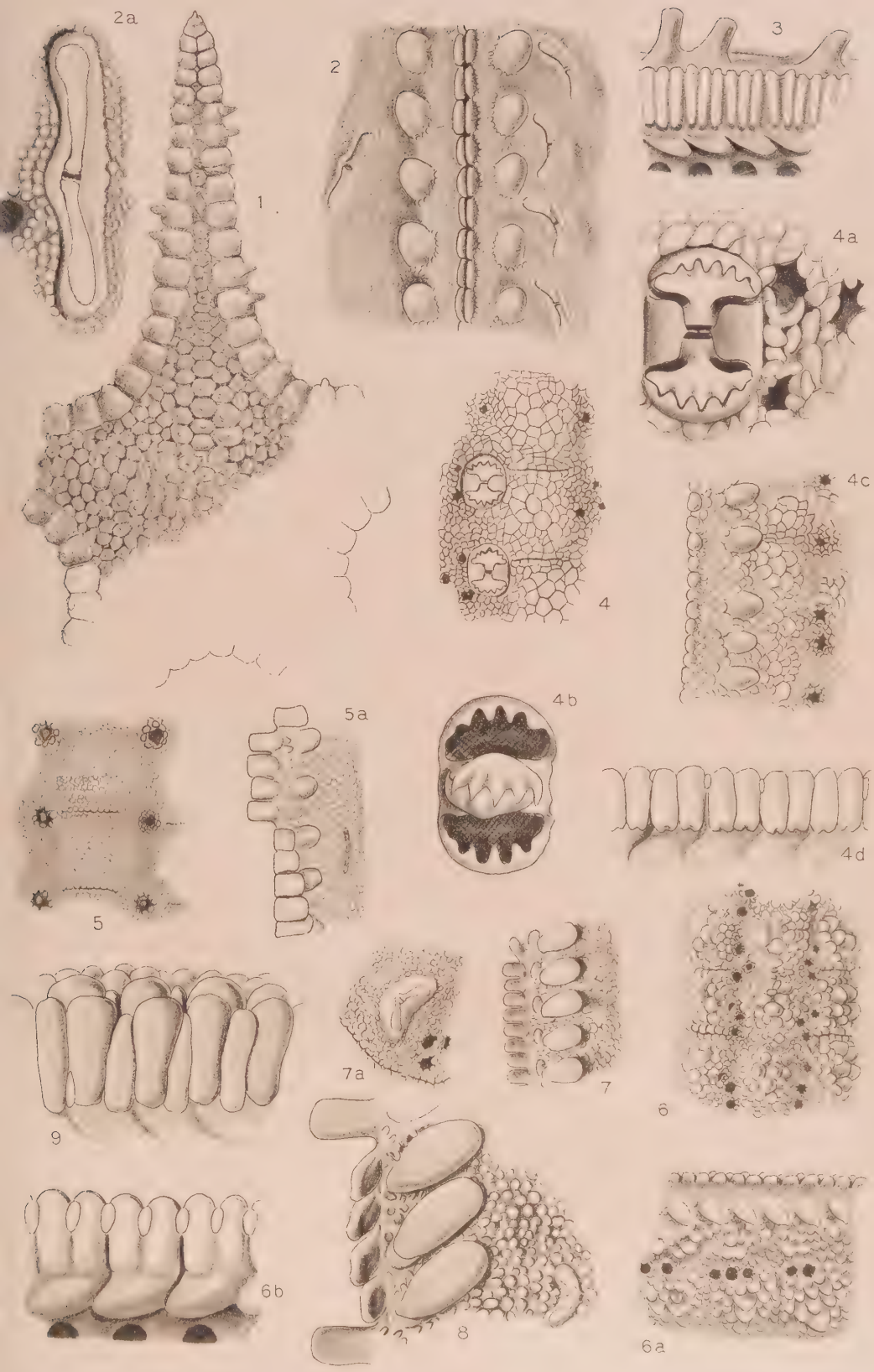
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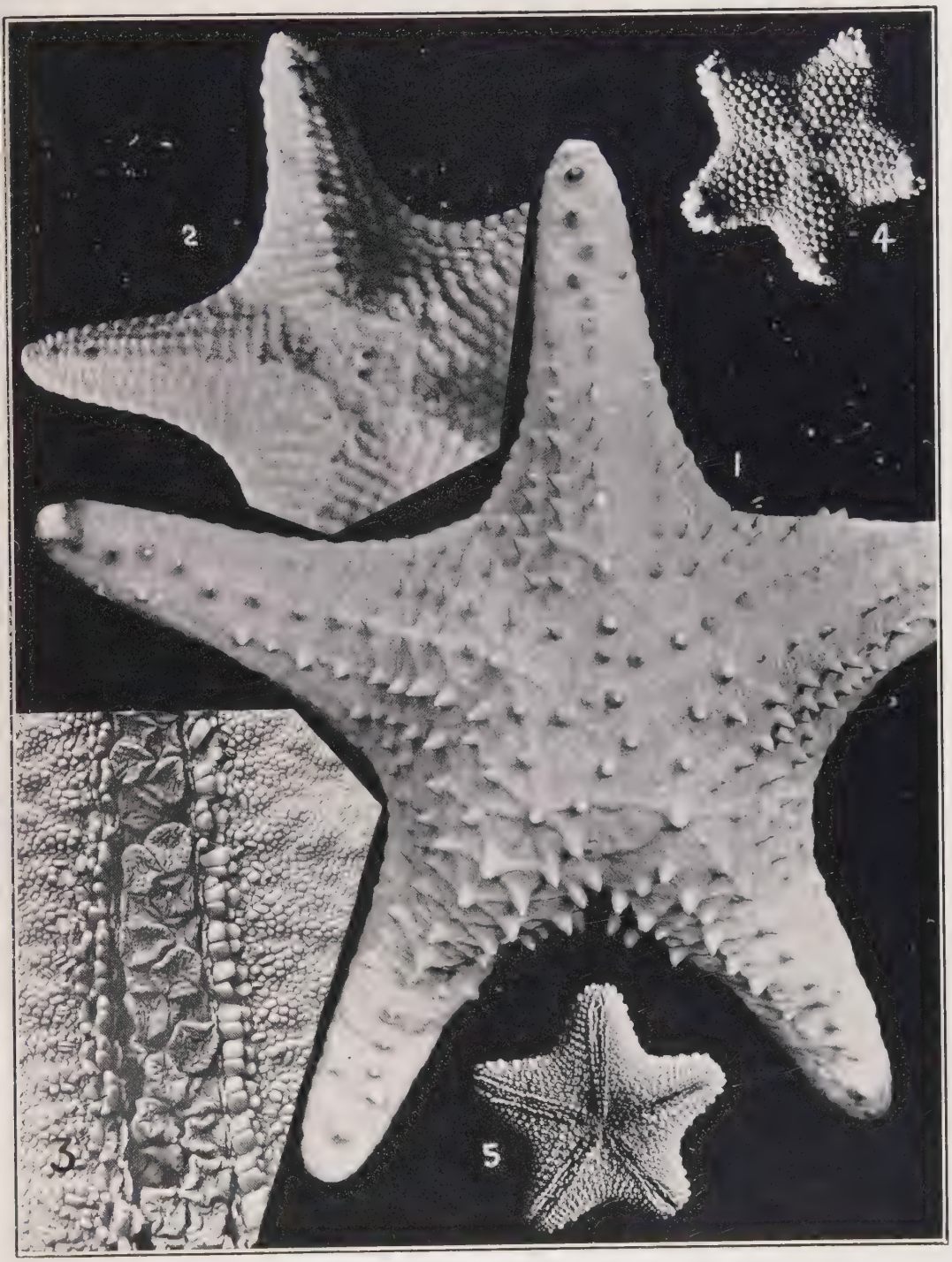
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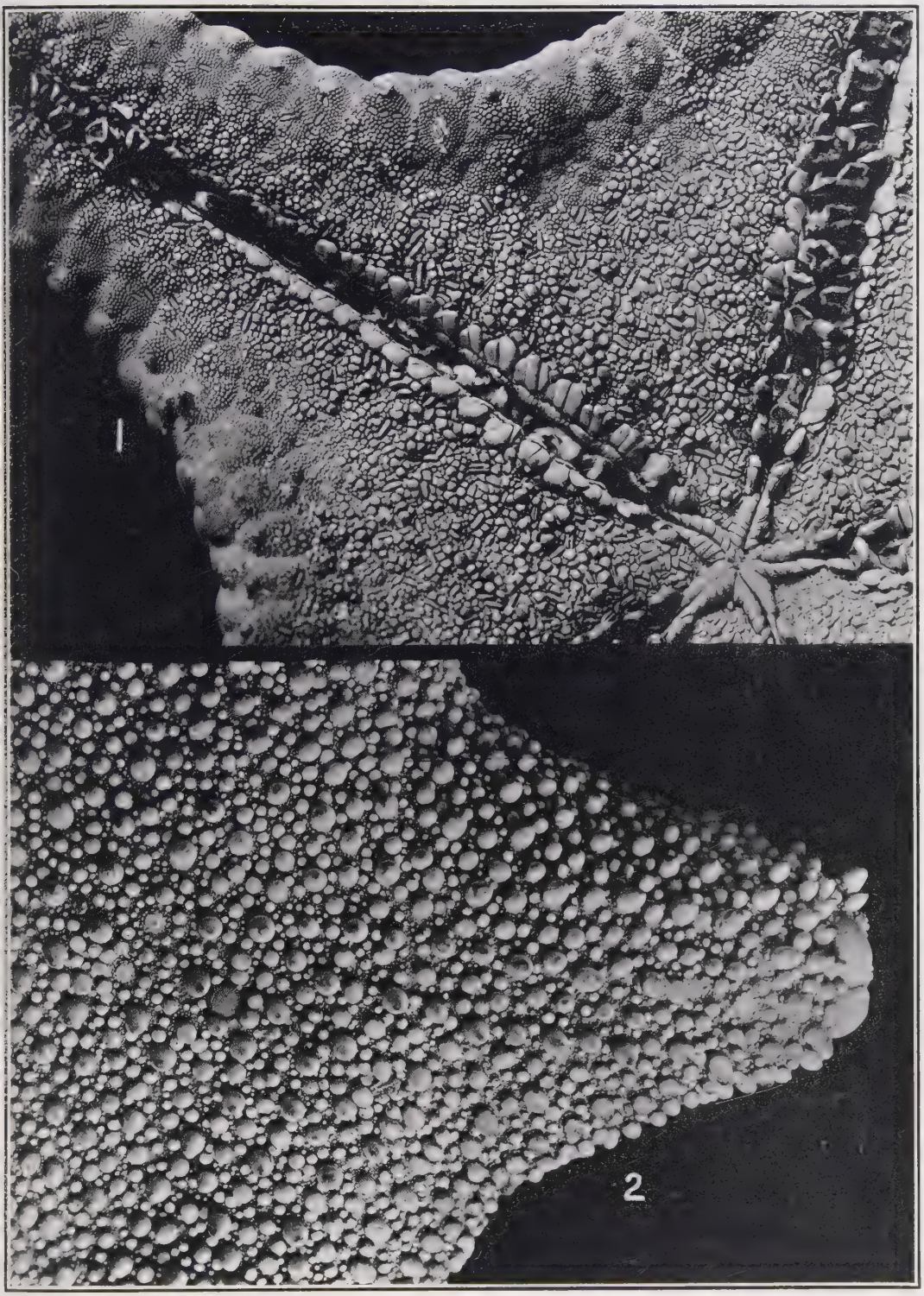
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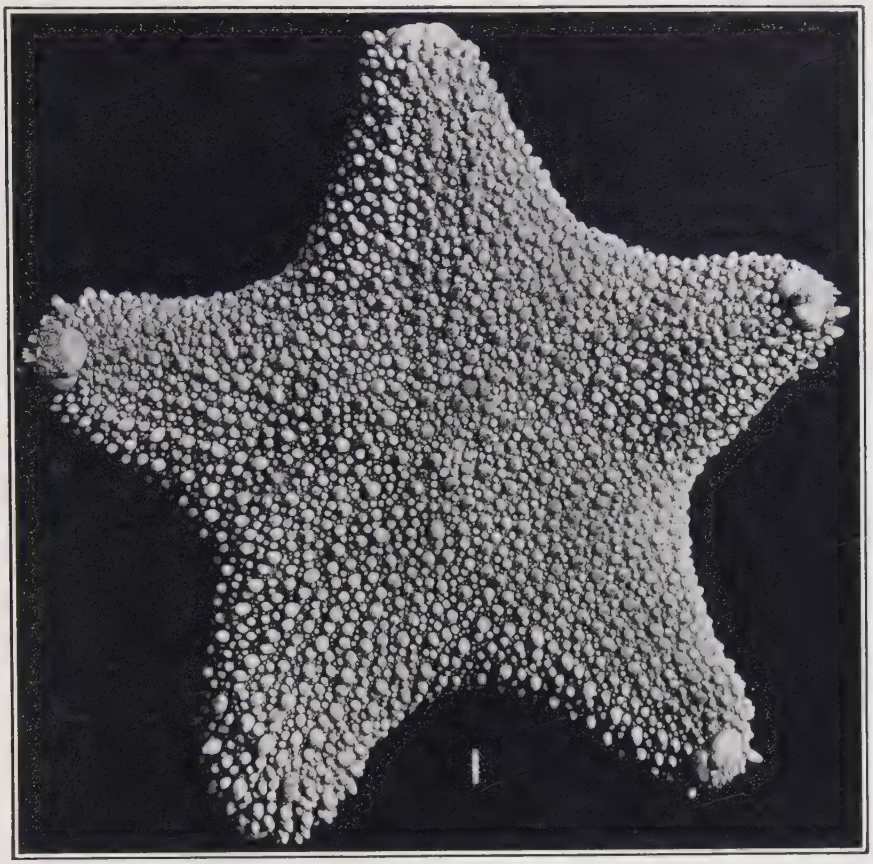

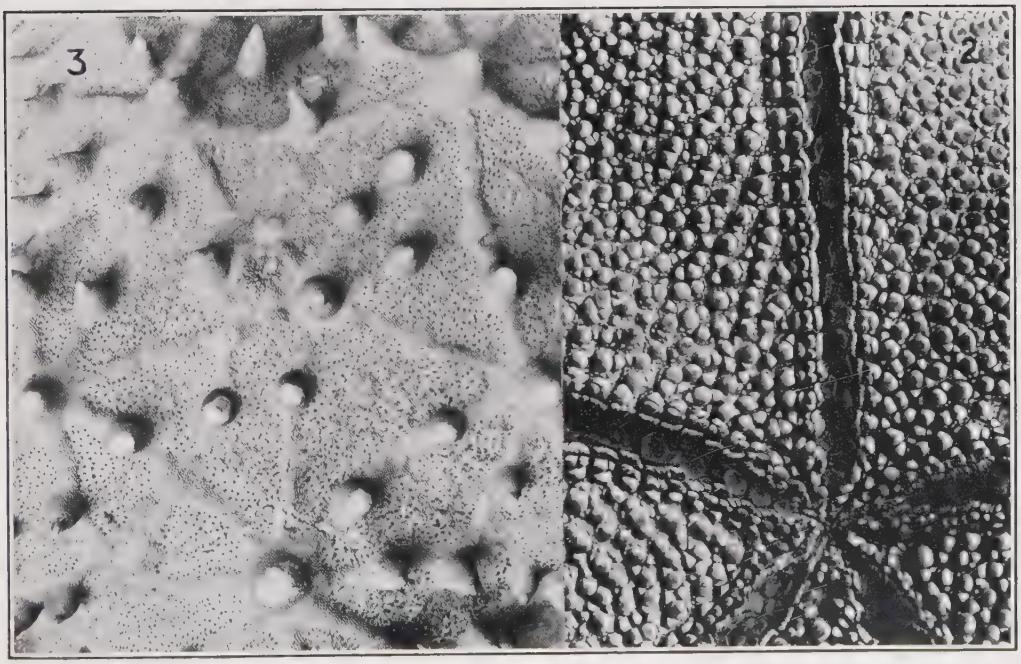
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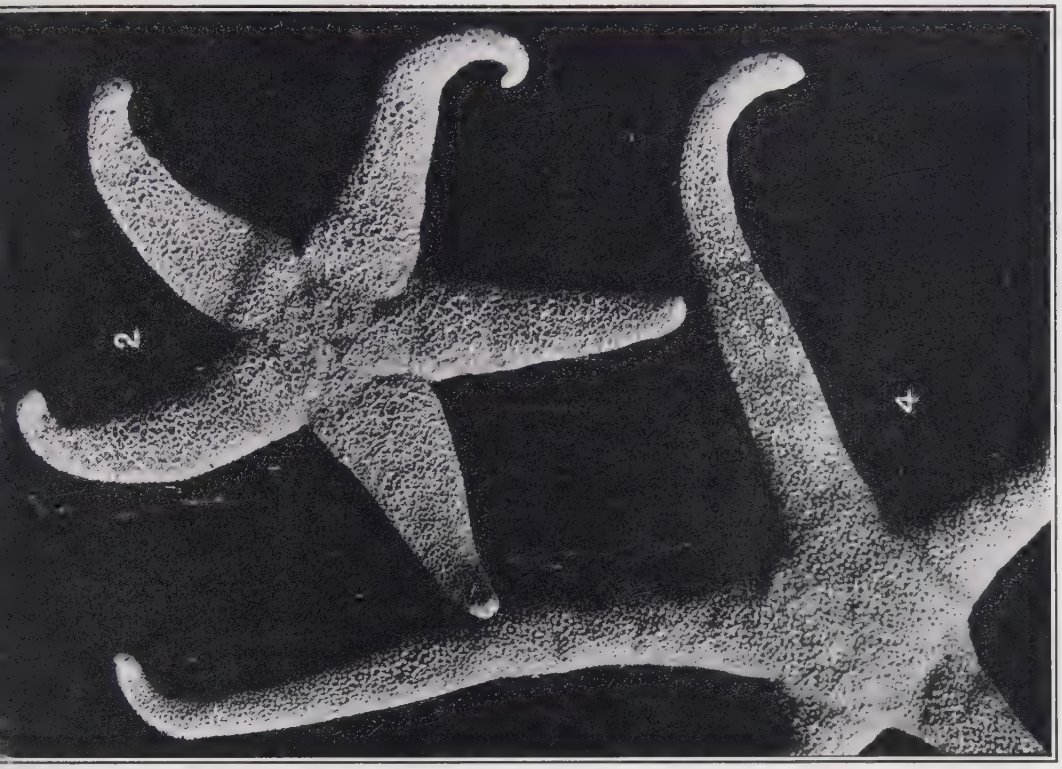
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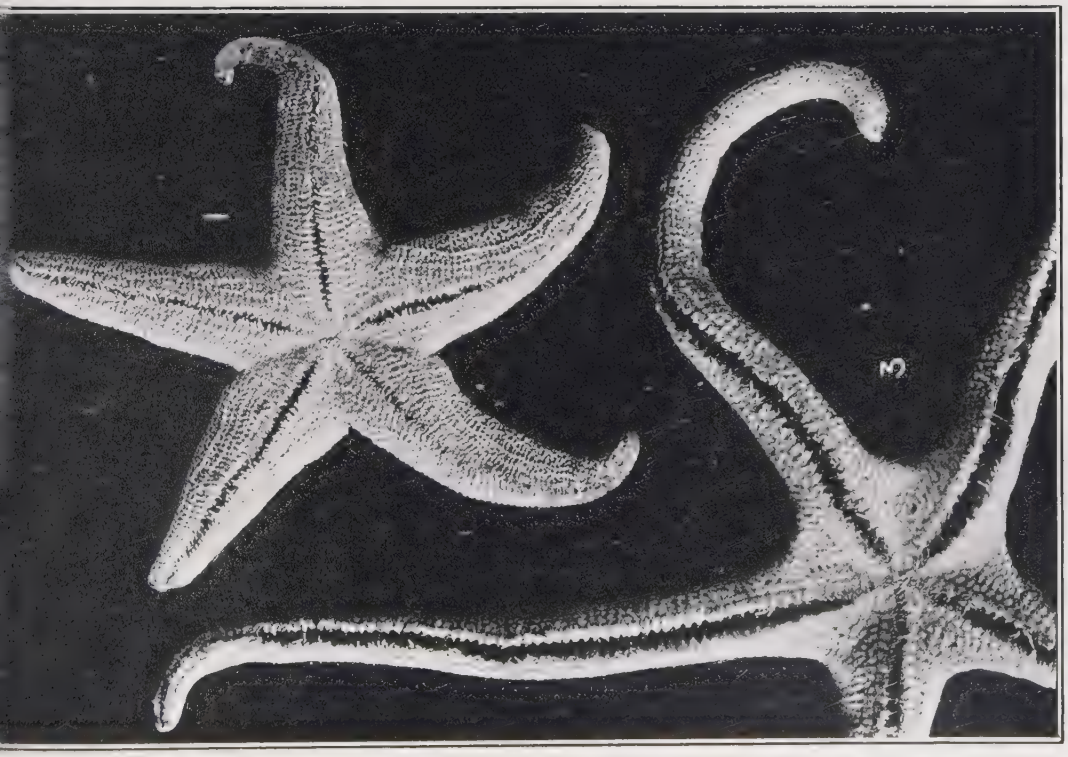
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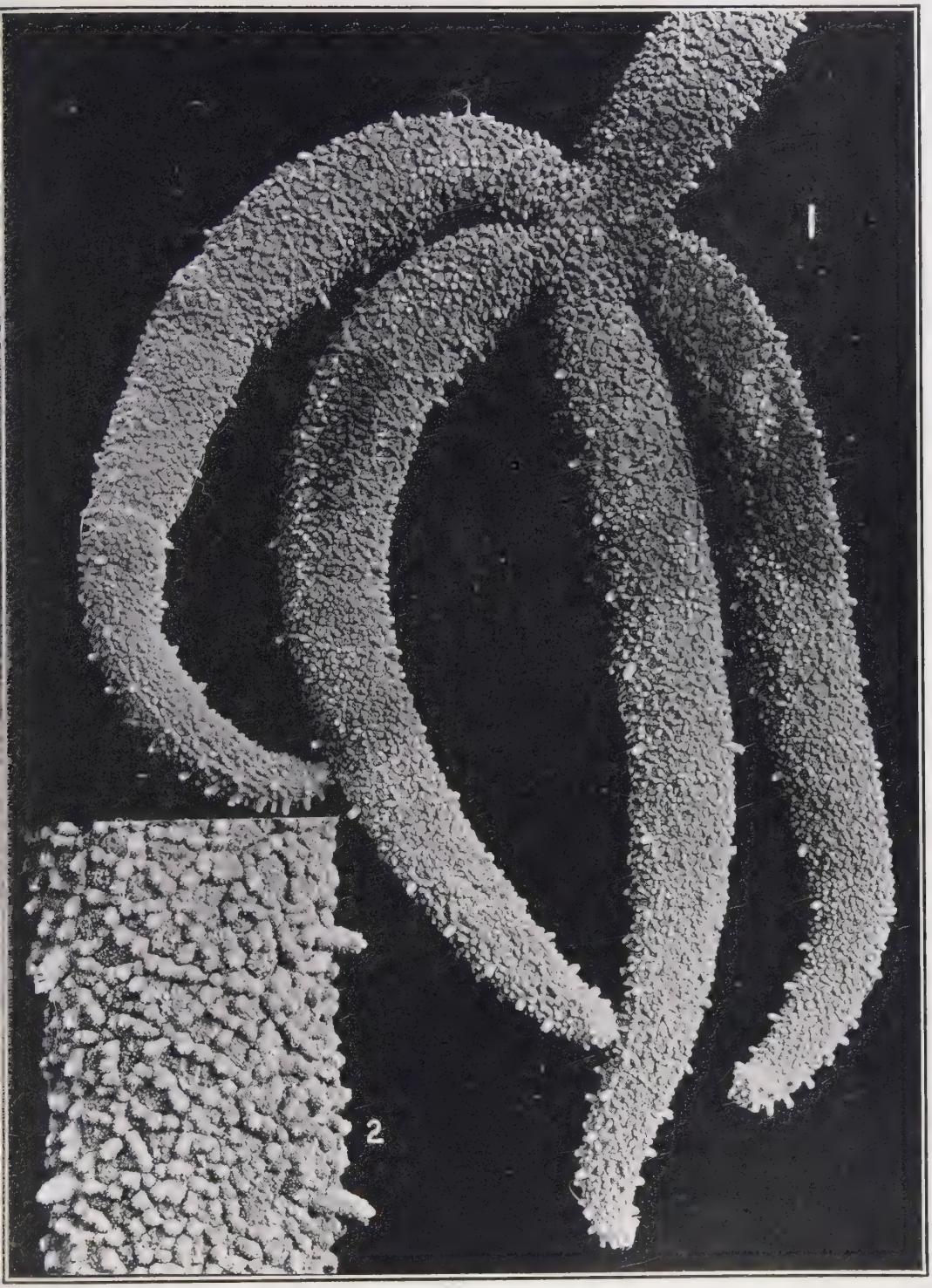
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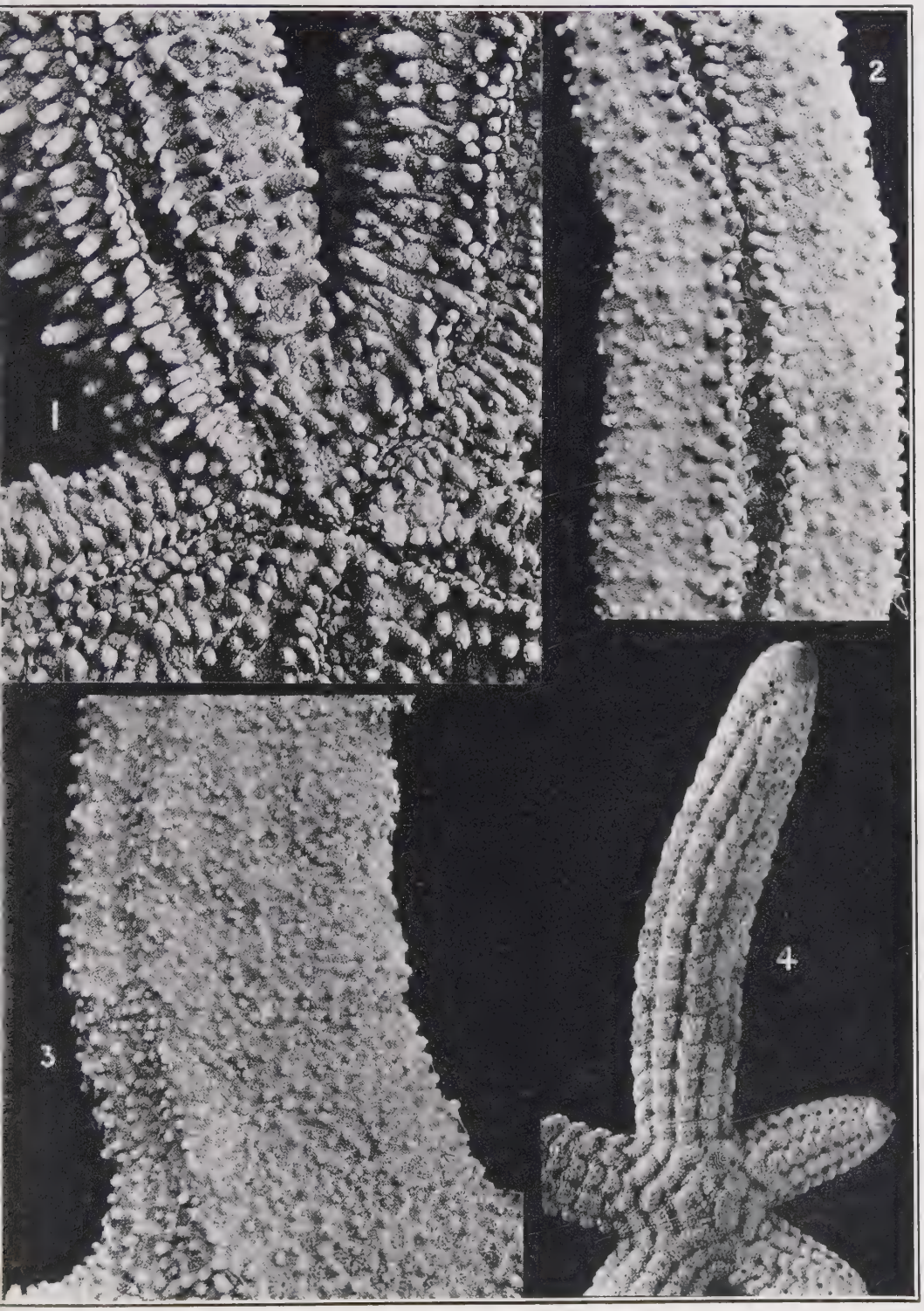
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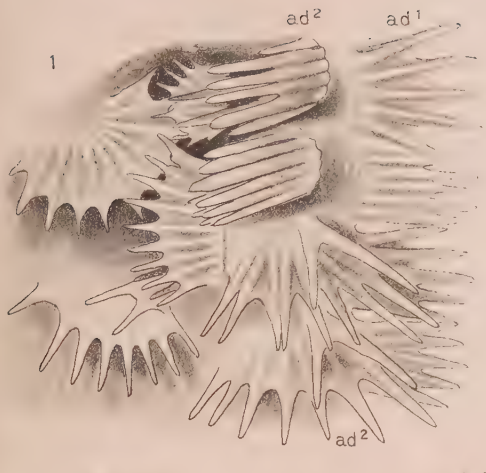

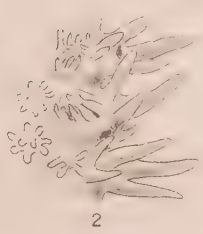

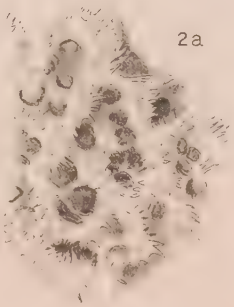

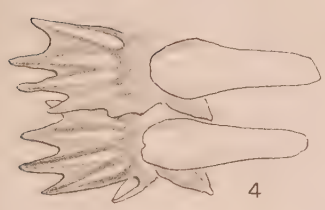

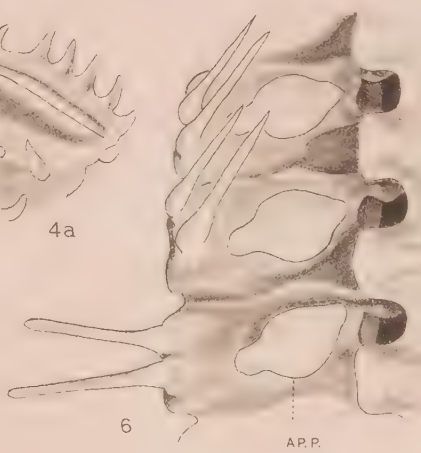

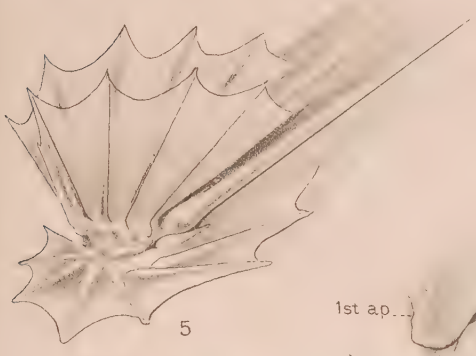

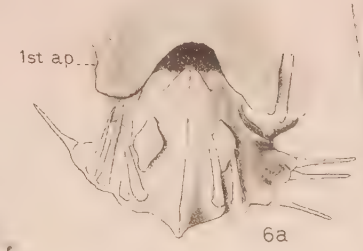

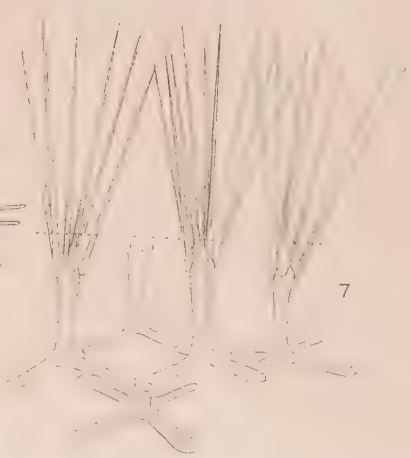

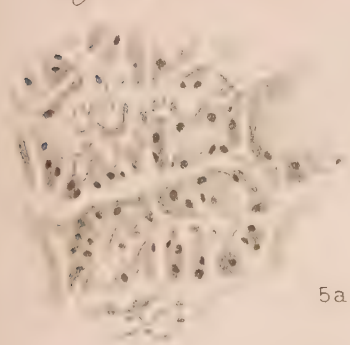

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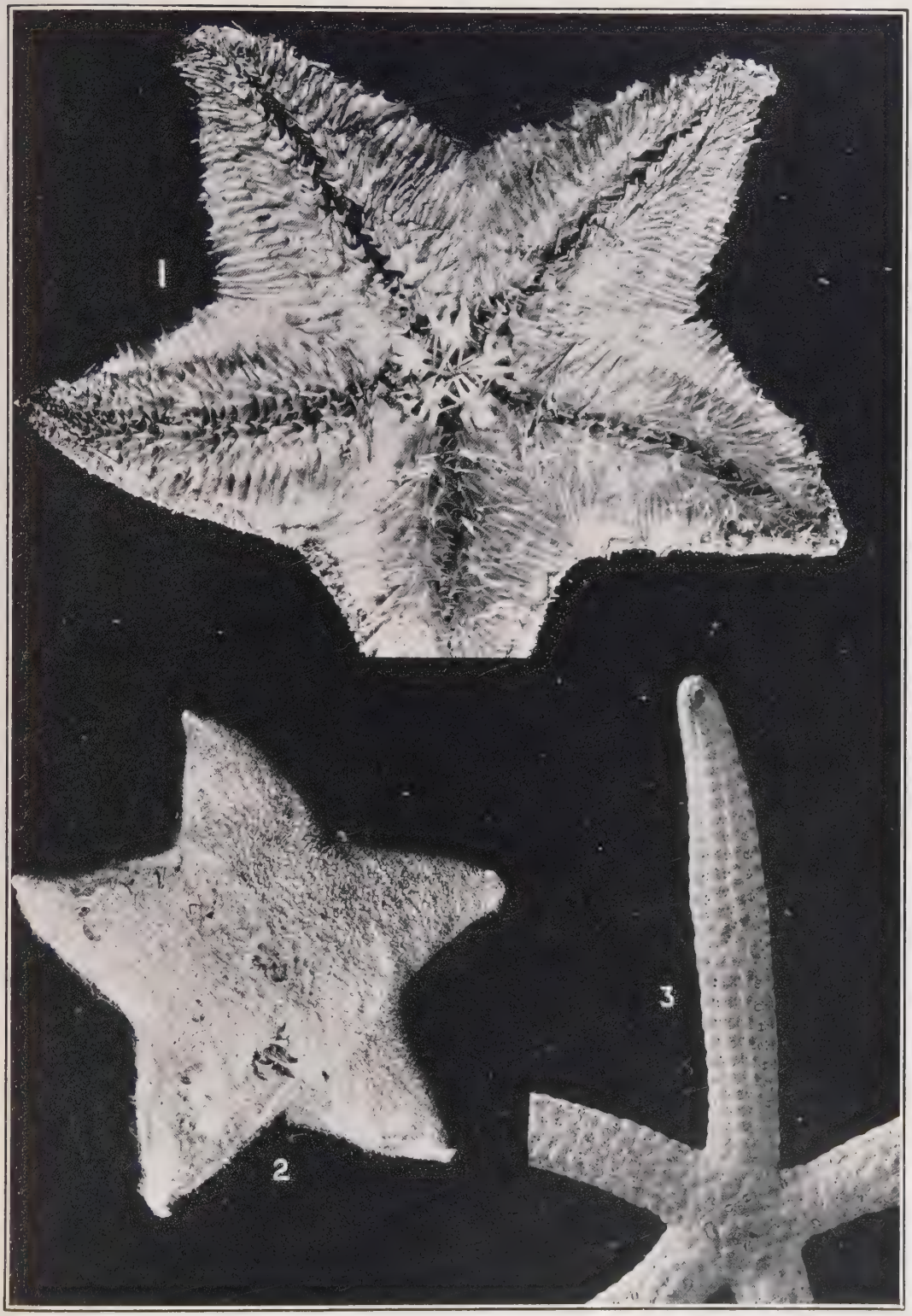
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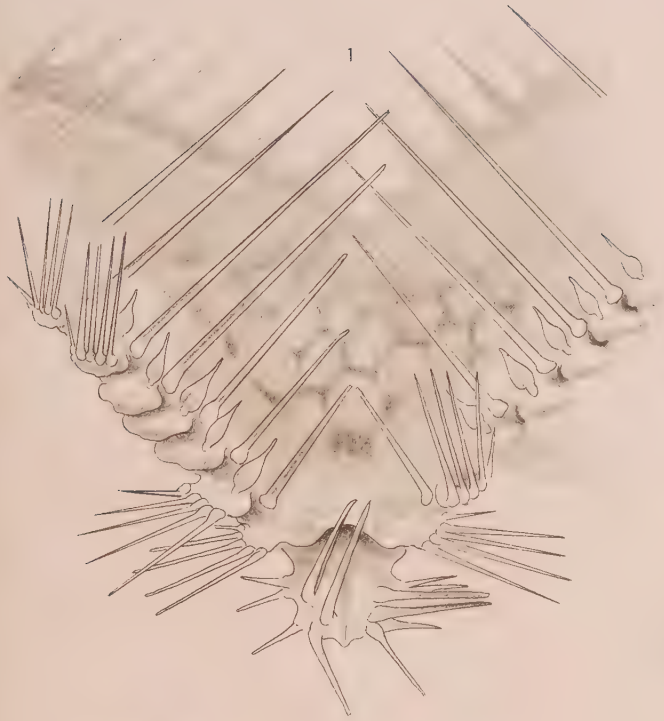

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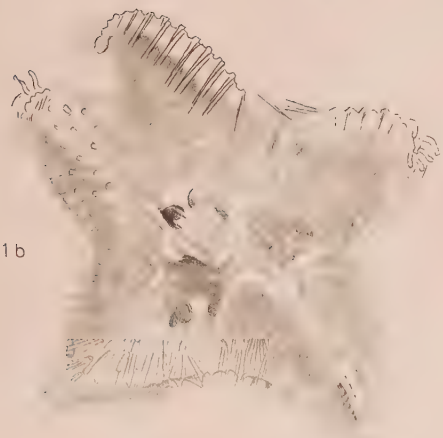

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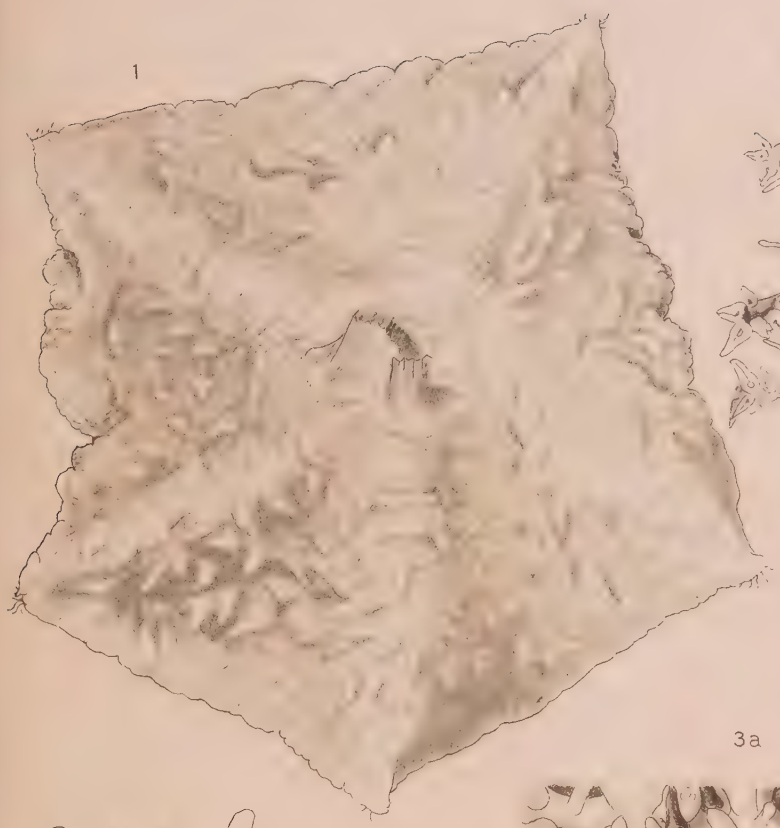
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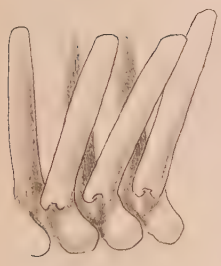
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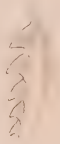
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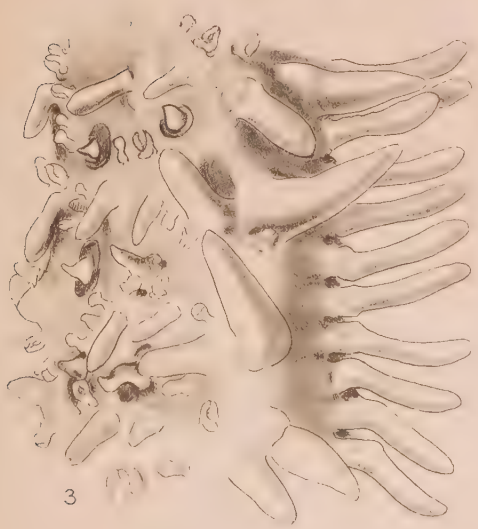
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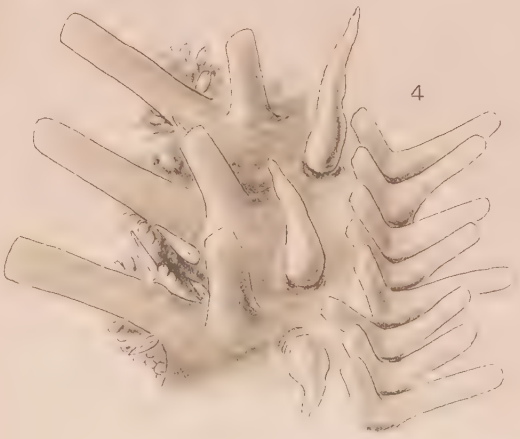
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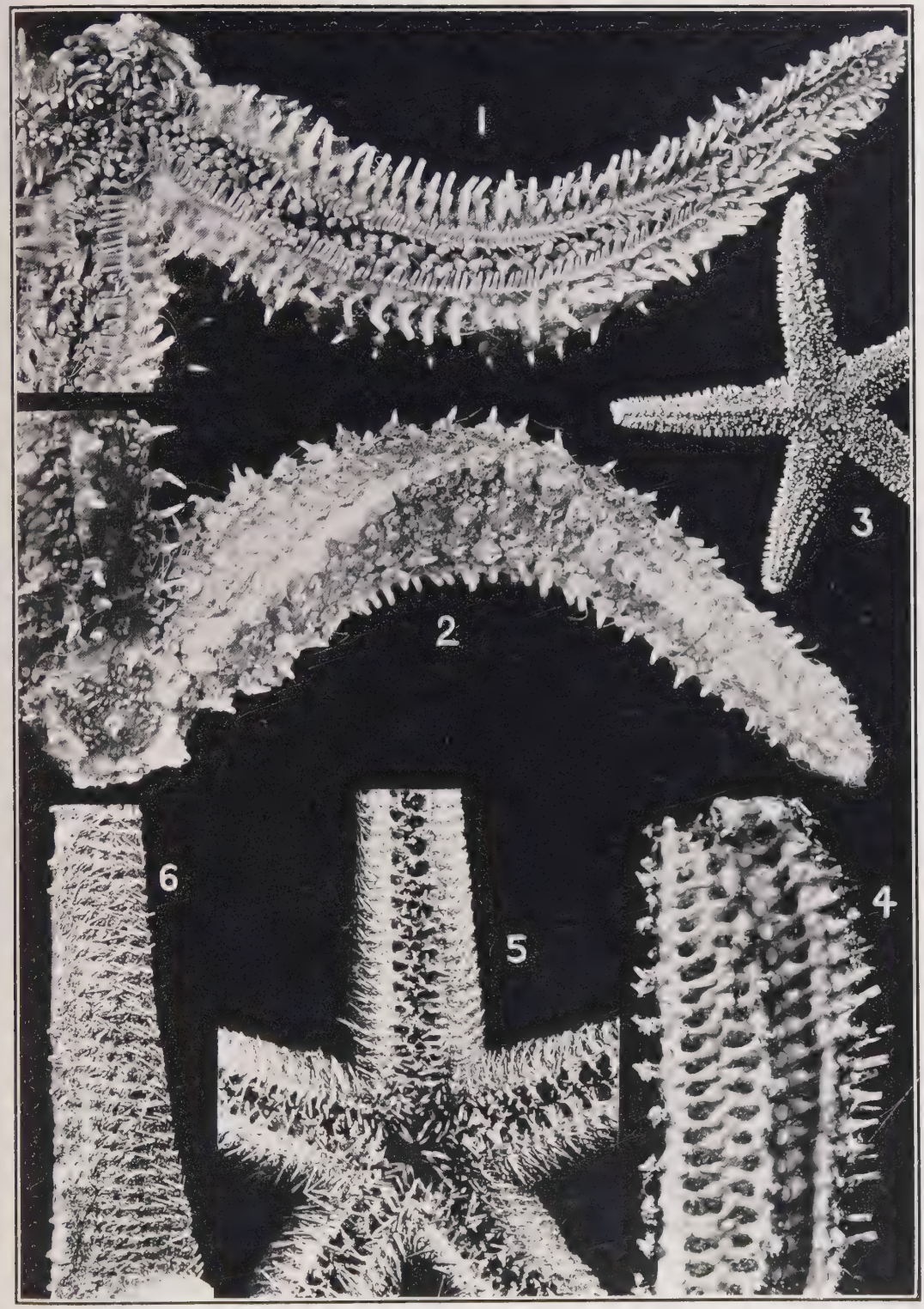
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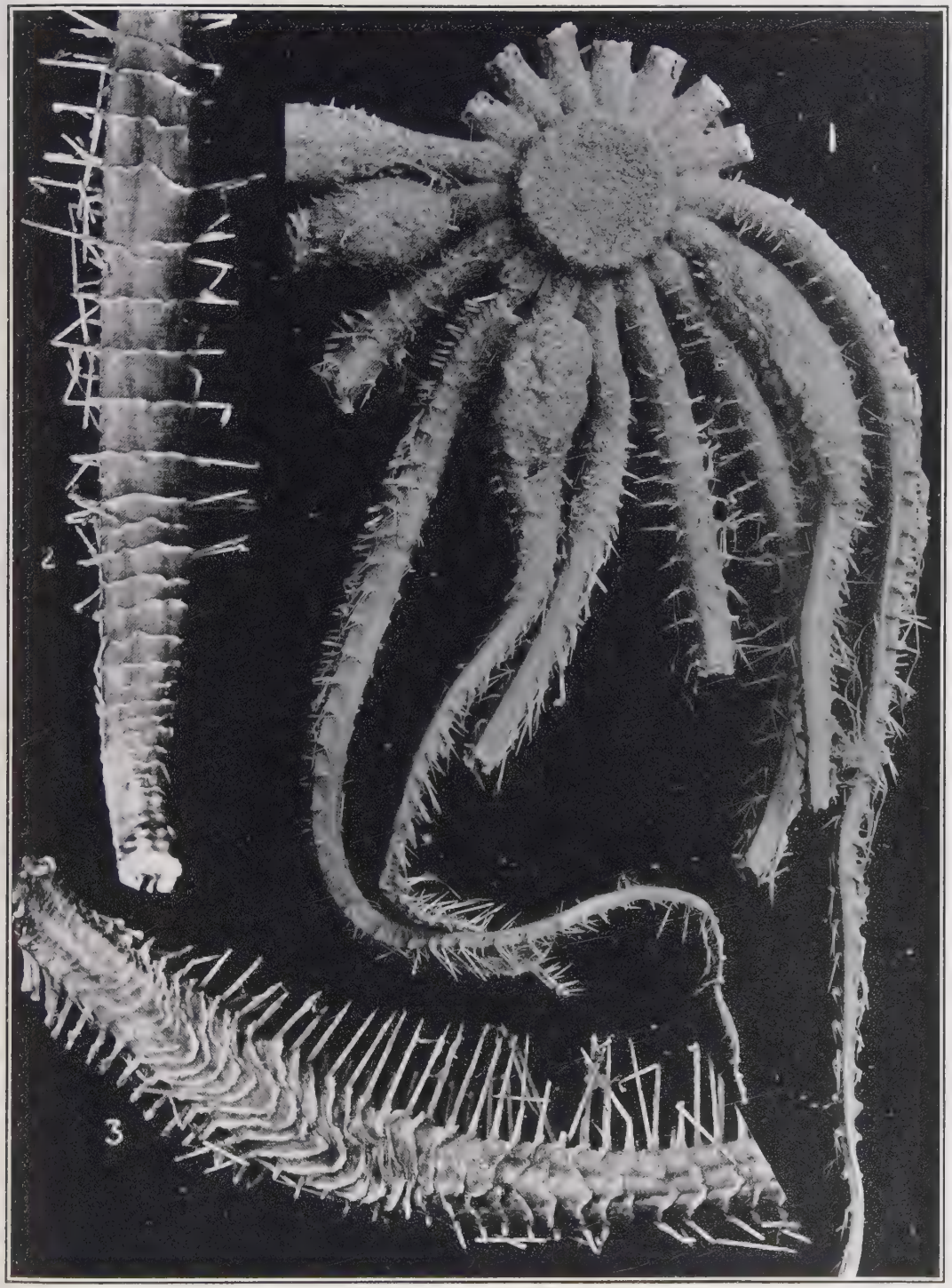
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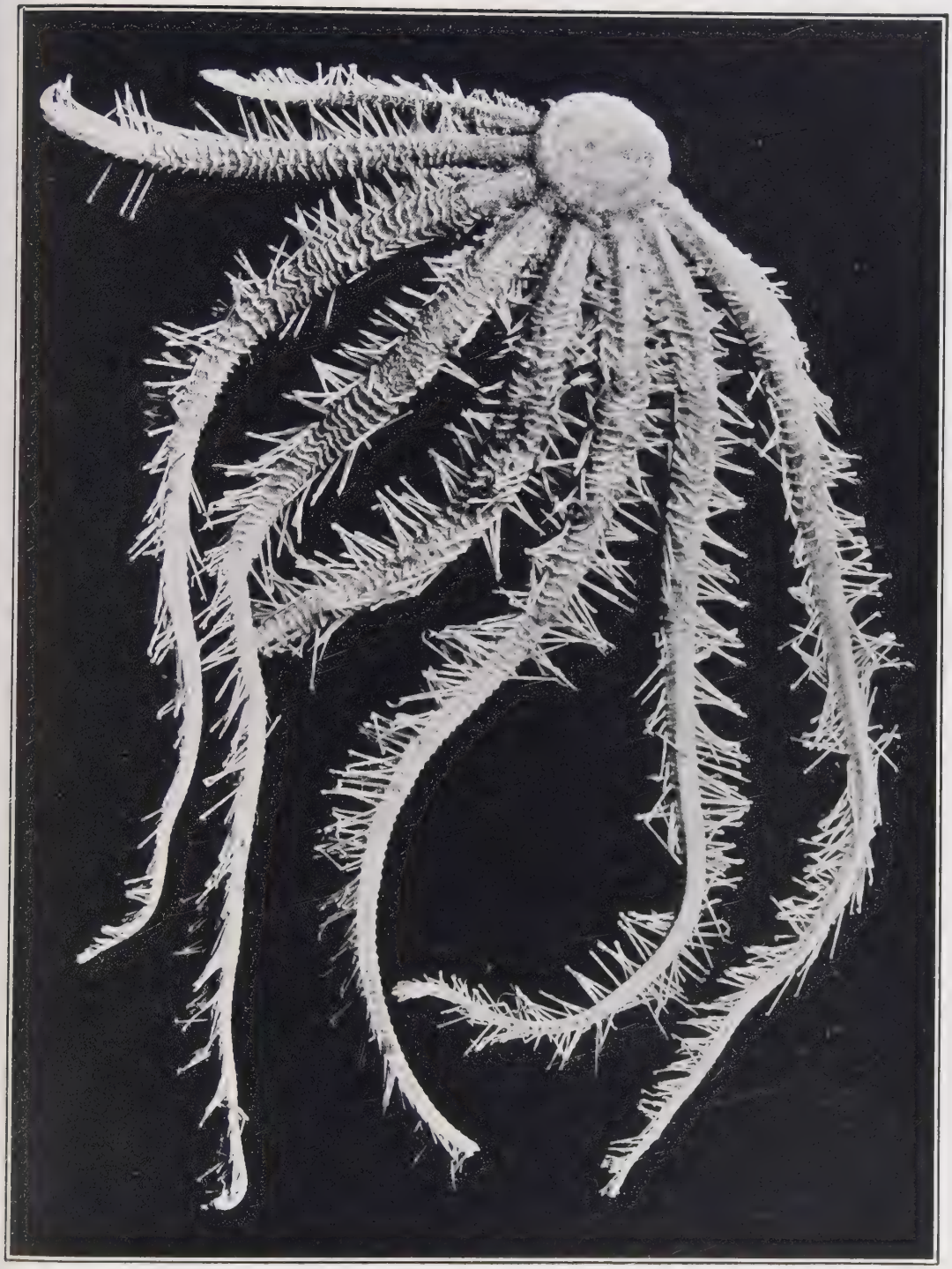
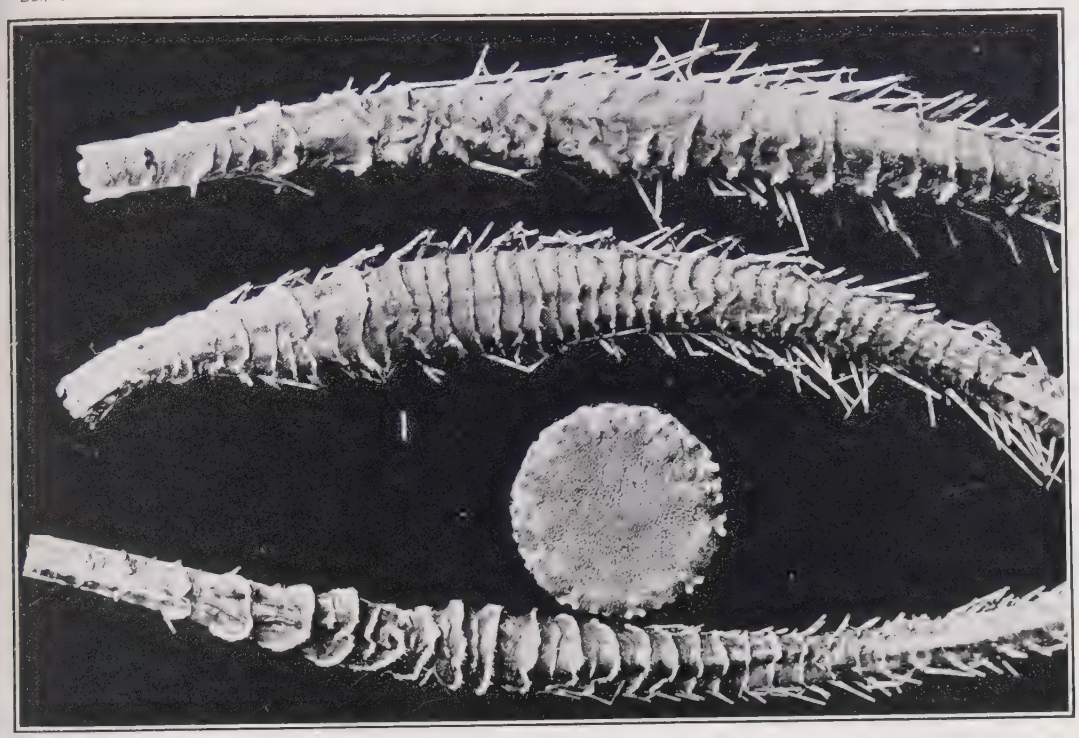


PLATE XLV.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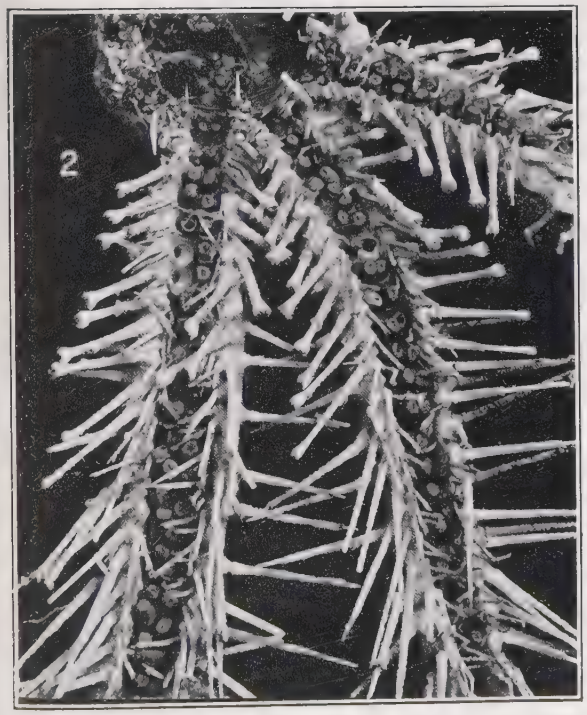
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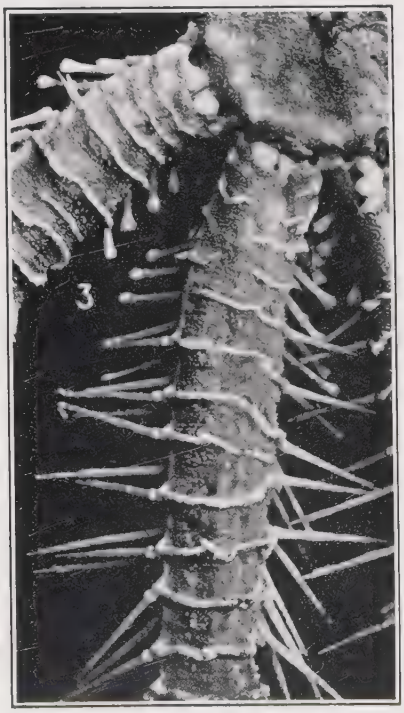
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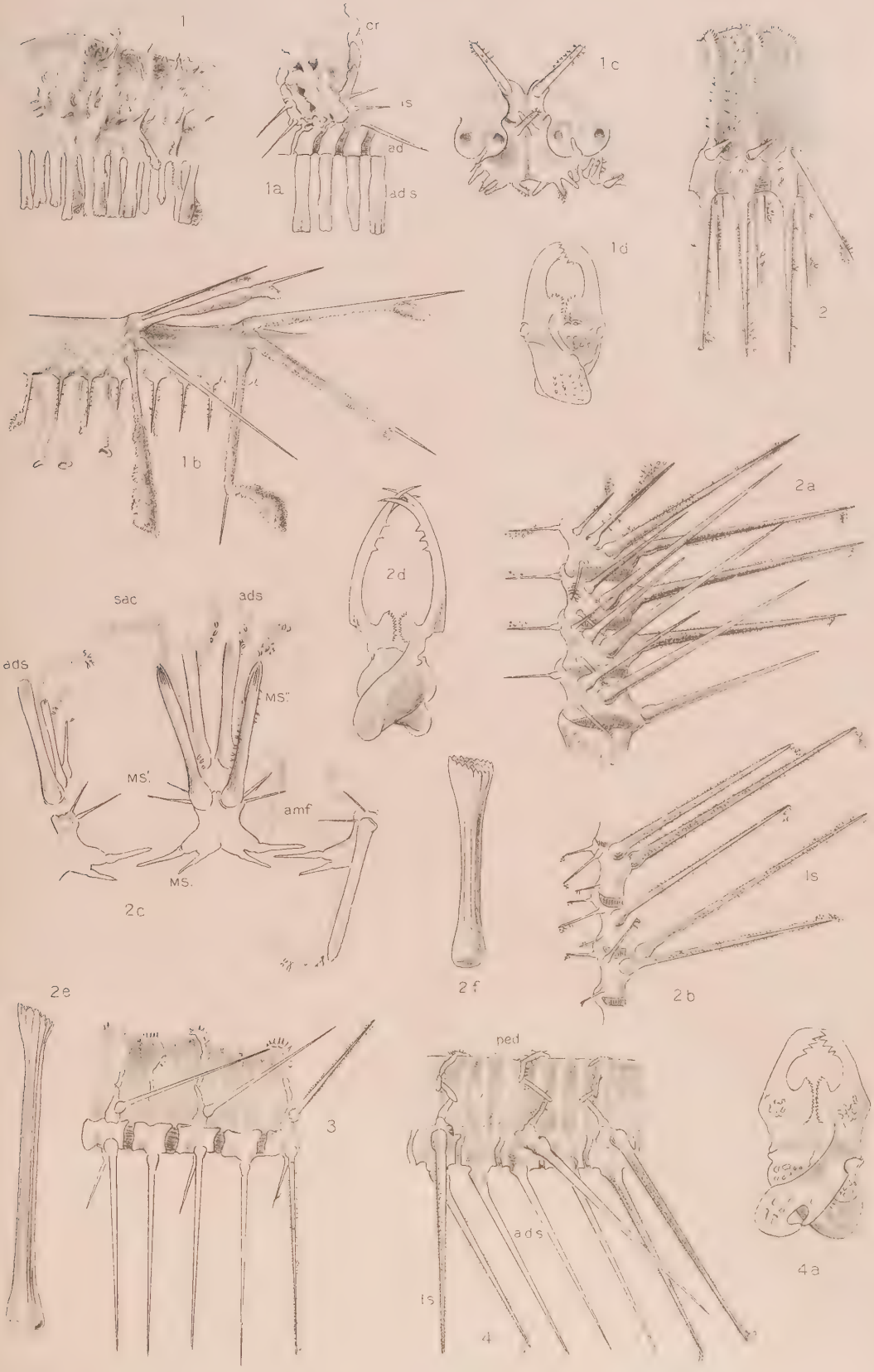

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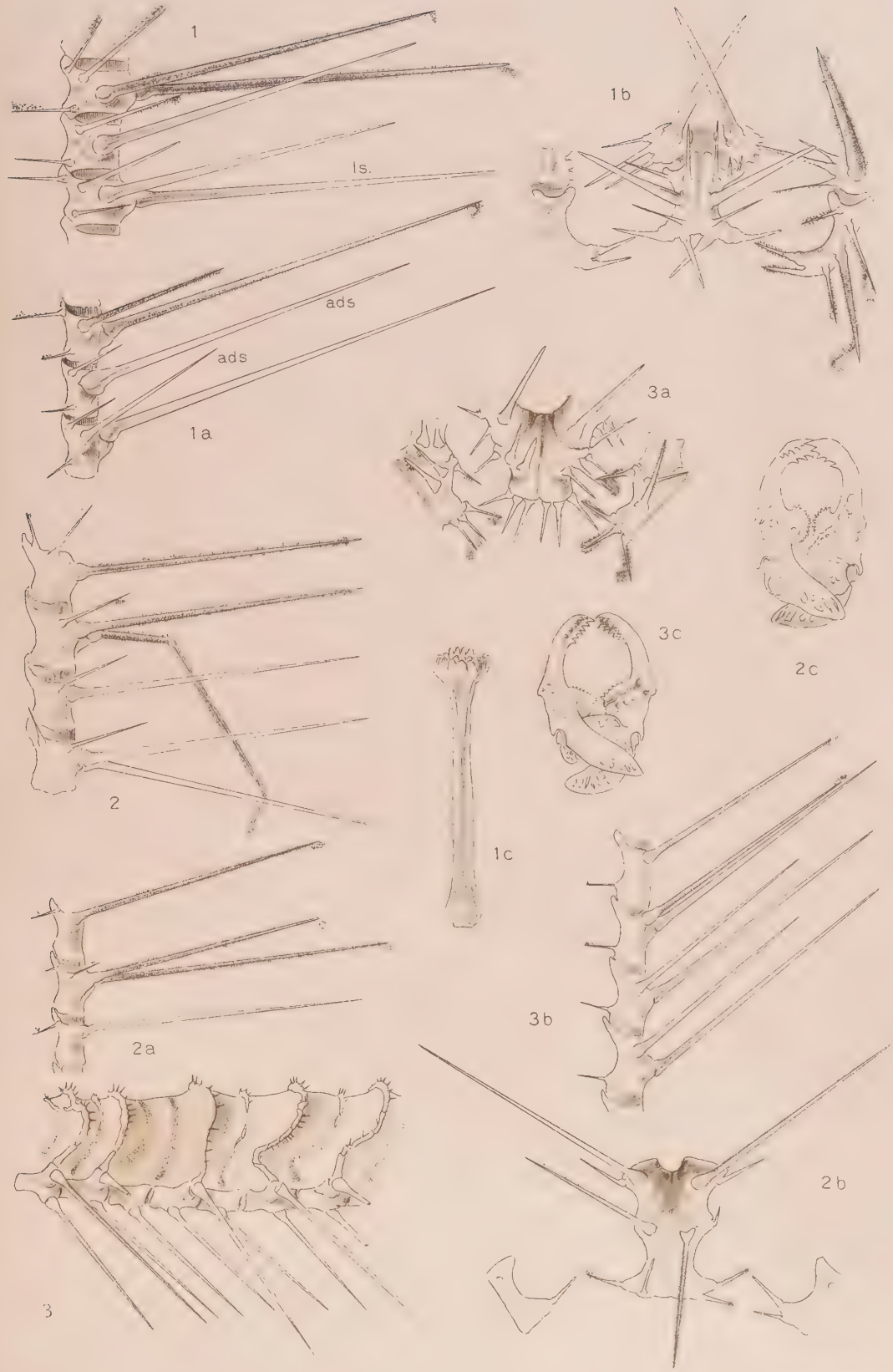

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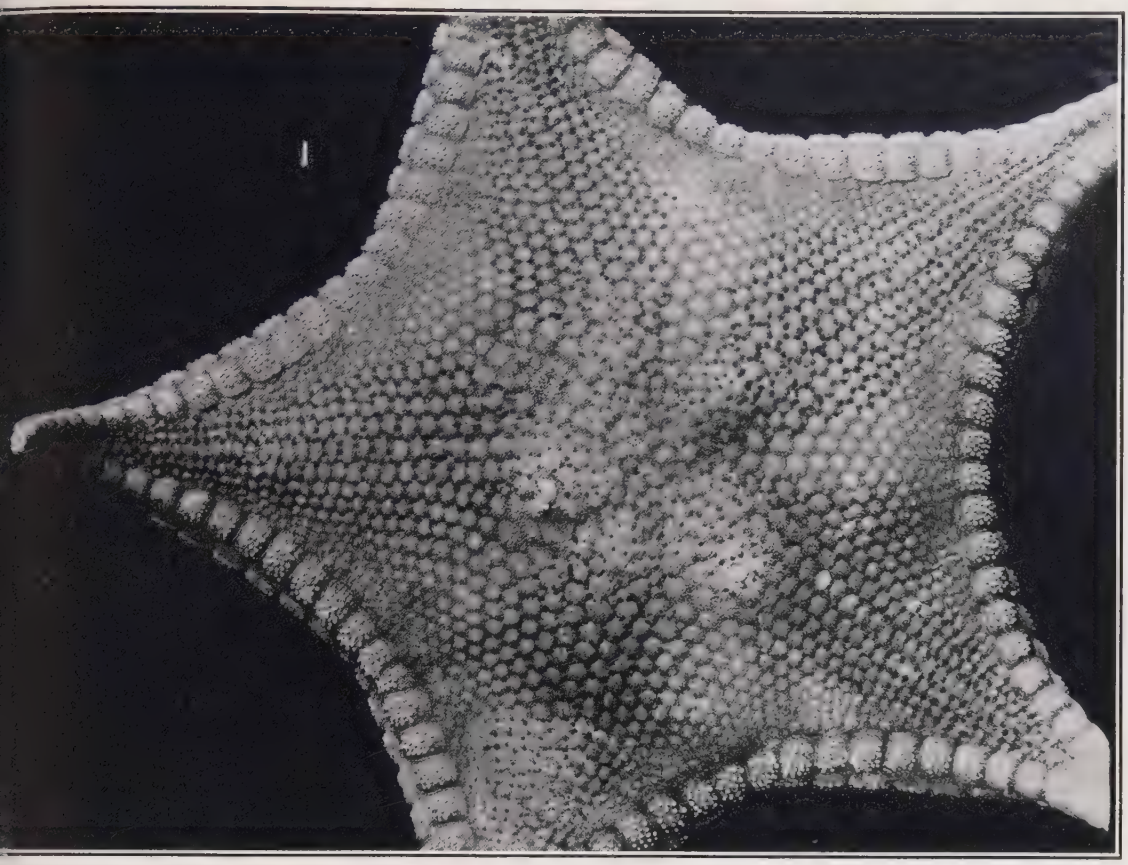
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MEDUSÆ OF THE HAWAIIAN ISLANDS COLLECTED BY THE STEAMER ALBATROSS IN 1902.

By ALFRED GOLDSBOROUGH MAYER,

Director of the Marine Laboratory of the Carnegie Institution at Tortugas, Fla.

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INTRODUCTION.

The following pages contain a description of the Scyphomedusæ, Hydromedusæ, Siphonophoræ, and Ctenophoræ collected by the *Albatross* while in the Hawaiian Islands in 1902 upon a cruise of scientific exploration under the direction of Dr. David Starr Jordan and Dr. Barton Warren Evermann. The collection is a small one, contained in 39 bottles, all of the specimens preserved in formalin. The preservative has destroyed the otoliths of the Hydromedusæ; and the color of many of the specimens has faded, rendering specific identification difficult or impossible. Accordingly only those forms which are well preserved are described.

When this collection obtained in the Hawaiian Islands is compared with those of Agassiz and Mayer in the Paumotu, Society, Fiji islands, etc., of Bigelow and Browne in the Maldive Islands, and of Maas off the west coast of Central America, it appears that the majority of the Hawaiian forms are of wide distribution. For example, among the Scyphomedusæ, *Charybdea rastonii* is found off the coast of South Australia near Adelaide. *Atolla alexandri* is found off the Galapagos and Marquesas islands. *Periphylla dodecabostrycha* is found on the deep ocean floor of both Pacific and Atlantic oceans, while *Pelagia panopyra* is found in the middle and western regions of the tropical Pacific. Indeed only one Scyphomedusa, *Charybdea moseri*, nov. sp., appears to be peculiar to the Hawaiian Islands, and this is represented in the Philippine Islands by a closely allied species.

Among the Hydromedusæ *Solmaris insculpta*, nov. sp., appears to be peculiar to the Hawaiian Islands, although it is represented in Samoa by a closely allied species. *Rhopalonema typicum*, found by the *Albatross* in station 3806, at a depth of 25 fathoms, between Erben Bank and Kaiwi channel, has been described from the Galapagos, Marquesas, Paumotu, and Maldive islands. Another *Trachylina* form is doubtfully identified from broken fragments as *Solmaris punctatus*, and is crudely figured and described by Quoy and Gaimard (1824, Voy. d l'Uranie, Zool., p. 564, pl. 85, fig. 4) from the Hawaiian Islands. Two specimens of this medusa were taken by the *Albatross* at station 3878, from a depth of 75 fathoms, off Molokini Islet, on April 14.

A single *Bougainvillia*, believed to be identical with *B. fulva*, was obtained by the *Albatross* at station 3806, from a depth of 25 fathoms, between Erben Bank and

Kaiwi channel. This species has been taken by Agassiz and Mayer in the Ellice and Fiji islands.

Four large but badly broken specimens of *Eutima* were taken by the *Albatross* at station 4010, on the surface between Kauai and Oahu, on June 20. They appear to belong to a new species peculiar to Hawaii, but their state of preservation is such as to render accurate description impossible.

Among the Siphonophoræ obtained in the Hawaiian Islands by the *Albatross* are *Diphyopsis angustata*, *Abyla huxleyi*, *Physalia utriculus*, *Porpita pacifica*, *Velella pacifica*, and an *Agalma* too broken for specific determination. Among these all but the last named are certainly of wide distribution over the tropical Pacific.

The Ctenophoræ are represented by *Hormiphora fusiformis*, found also in the Marquesas and Paumotu islands, and a *Beroe* apparently identical with *B. australis* Agassiz and Mayer, from the Ellice and Fiji islands.

On the whole it appears that the medusa fauna of the Hawaiian Islands is mainly an insular one, recruited from forms capable of extensive distribution. The isolation of the islands and the relative smallness of their coastal areas have probably hindered the development of any considerable number of species peculiar to the locality.

It is remarkable that no Rhizostomæ were found in Hawaiian waters, although these Scyphomedusæ are very characteristic of Fiji, Australia, and the Malay Archipelago. Bigelow (1904, p. 248), however, calls attention to the fact that they are not commonly found among the Maldive Islands.

DESCRIPTION OF SPECIES.

SCYPHOMEDUSÆ.

Genus CHARYBDEA Péron et Lesueur, 1809.

Charybdea, Haeckel, Syst. der Medusen, p. 439, 1880.

Generic characters: Cubomedusæ with 4 simple interradial tentacles, with pedalia. The velarium is suspended by 4 radially situated bracket-like frenulæ from the walls of the subumbrella. Velar canals are found extending from the gastro-vascular space of the medusa into the entodermal lamella of the velarium. The stomach is wide and flat without wide mesenteries. There are 4 clusters of gastric cirri situated in the interradial angles of the stomach cavity.

Charybdea rastonii Haacke

Pl. 1, figs. 1–1c.

Charybdea rastonii Haacke, W., Jena. Zeitschrift, 1887, p. 599, taf. 35, 15 fig.

Specific characters: The bell is nearly cubical, with flat top and almost plane sides. It is about 35 mm. high and 30 mm. wide. The 4 interradial pedalia are small, being only about 10 mm. long and 6 mm. wide. Each pedalium is hollow, and gives rise to a hollow tentacle, which is about 50 mm. long and closely ringed with nematocyst swellings. These tentacles taper gradually from base to tip, and are very flexible. There are four short club-like sense organs, alternate in position with the four tentacles, each sense organ found within a niche about 5 mm. above the level of the velarium, and knob-shaped with a short stalk. The sensory knob is provided with an entodermal otolith and 6 ectodermal eyes. Two of these eyes are large and median, and provided each with a doubly convex lense, while the other 4 eyes are small and lateral and are little more than ocelli. All of the eyes are directed inward, so as to view objects within the bell. (Figs. 1b, 1c, pl. 1.)

The velarium is wide, and is suspended by 4 radial mesenteries, or bracket-shaped frenulæ. Sixteen short, non-anastomosing velar canals extend inward into the substance of the velarium. (Fig. 1a, pl. 1.) There are 4 short interradial regions in the corners of the stomach, where one finds many

small gastric cirri. The manubrium is flat and wide, and 4 large, wide, flat, radial pouches extend outward from the stomach. These are partially separated one from another by 4 narrow, interradial partitions, extending from the corners of the stomach to the base of the pedalia. The radial pouches are in communication one with another only through the axial cavities of the pedalia. The 8 gonads are leaf-like, and are attached to the sides of the 4 interradial partitions, from which they project into the cavities of the radial pouches. They extend along the entire length of each interradial partition. Each gonad is widest near the region of the stomach, and tapers gradually to the region of the pedalium, so that each pair of gonads attached to the same interradial partition presents a pyriform outline. (Fig. 1, pl. 1.) The gelatinous substance of the bell is hyaline, the entodermal parts being milky. According to Haacke's description, the flexible shafts of the tentacles and the interradial gastric cirri are dull pink.

The gonads begin to develop when the medusa's bell is only 11 mm. high, and are large in medusæ in which the bell is 15 mm. high. The relatively wide, flat-topped bell is characteristic of this medusa in all stages, from those 11 mm. high to maturity, when the bell is fully 35 mm. in height.

This medusa was obtained by Haacke (1887) in the Gulf of St. Vincent, South Australia, in South latitude 35°. Forty-one specimens were obtained by the *Albatross*, 16 of these being caught at night by means of a net and an electric light, near the surface off the wharf at Honolulu.

Record of Hawaiian specimens.

No. of specimens.	Date.	Station.	Geographical position.	Depth.	Remarks.
	1902.			*Fathoms.*	
3	July 19	4067	Puniawa Point, Maui Island.	10–14	All one-half to one-third grown.
15	do	4068	do	14–18	All about 12 mm. high, with small gonads about 4 mm. wide.
4	do	4069	do	18–23	All about 14 mm. high, with well-developed gonads.
16	Mar. 30, night	Wharf at Honolulu	Island of Oahu	Surface.	Caught by aid of electric light, in dip net, at night. All well-grown medusæ with bells about 35 mm. high. One of these figured.
3	June 23	Hanalei	Island of Kauai		All of medium size.

Charybdea moseri, new species.

Pl. 1, figs. 2–2c.

? Semper, C., Zeit. für Wissen. Zool., bd. XIII, 1863, taf. 39., fig. 9.

This species is named in honor of Capt. Jefferson F. Moser, U. S. N., formerly commander of the *Albatross*.

The bell in large medusæ is about 80 mm. high and 47 mm. wide. The pedalia arise from the 4 interradial corners of the base of the bell as four short stalks, each of which gives rise to a wide flat spatula-like expansion, from which arises the long flexible portion of the tentacle. These tentacles are ringed at close intervals with clusters of nematocysts. They are hollow, and the canal, which connects their lumen with the gastro-vascular cavity of the bell, extends through the ring-like, flat, expanded portion of the pedalium. The basal stalks of the pedalia are only about 3 mm. long, the flat spatula-shaped, or wing-like, portion is 18 mm. long and 16 mm. wide, while the flexible parts of the tentacles are each about 80 mm. long.

There are 4 radially situated, club-shaped sense organs, each in a wide cleft-like niche, about 15 mm. above the margin of the velarium. The sensory part of each sense-club is pear-shaped and bears an entodermal, abaxial mass of otoliths, and four ectodermal ocelli. Two of these are large, and are provided with double convex lenses, while the other two are lateral and are mere pigment spots. The eyes are so arranged as to be directed toward the interior of the bell. (Figs. 2b, 2c).

The velarium is quite wide, and is supported at its 4 radial points by bracket-like frenulæ. Twenty-four simple non-branching diverticulæ, 6 in each quadrant, extend from the gastro-vascular space of the bell into the velarium. (Fig. 2a).

The manubrium is wide and shallow, with a four-cornered mouth, and simple lips. There are numerous short, simple, unbranched gastric cirri, in crescent-shaped areas, at the four interradial corners of the stomach.

The central stomach gives rise to 4 radial pouches, which extend out into the substance of the bell. These pouches are incompletely separated one from another by 4 narrow interradial septæ, which extend from the interradial corners of the stomach to near the basal stalks of the pedalia.

The gonads are leaf-like, are attached to the sides of the interradial septæ, and extend from the corners of the central stomach to within 8 mm. of the level of the velarium.

In medusæ preserved in formalin the flexible shafts of the tentacles are slightly pink, the eye spots are dark brown, and the gonads are milky yellow. The gelatinous substance of the bell is thin and hyaline, but of fairly rigid consistency.

This medusa resembles in some respects the form figured and briefly mentioned by Semper (1863) from the Philippine Islands. It is distinguished from Semper's medusa, however, by the very short basal stalks, and the different shape of the spatula-like "wings" of the pedalia. It can readily be distinguished from *C. rastonii* in all stages by its high, narrow bell, and wholly different pedalia. Also in *C. rastonii* the gonads are seen even in medusæ whose bells are but 12–13 mm. high, whereas in *C. moseri* the gonads do not begin to develop until the bell is fully 60 mm. high.

Twenty-three specimens of *C. moseri* were obtained by the *Albatross* among the Hawaiian Islands. With the exception of one specimen they were all obtained at the surface, the exceptional specimen being a small one from a depth of 25 fathoms. Type no. 21800 U. S. National Museum.

Record of Hawaiian specimens.

No. of specimens.	Date.	Station.	Geographical position.	Depth.	Remarks.
	1902.			*Fathoms.*	
1	Mar. 22	3806	23° 25′ 36″ N.; 152° 24′ 30″ W.	25	Small. No gonads.
10	Apr. 1–2	3829	Avalu Point, Lanai Island.	Surface.	Bells about 80 mm. high. Well developed gonads; one of them figured.
2	May 11	3927	21° 31′ N.; 161° 55′ W.	Surface.	Medium size. No gonads.
1	May 13	3929	23° 19′ N.; 166° 54′ W.	Surface.	Do.
1	May 15	3930	25° 07′ N.; 170° 50′ W.	Surface.	Do.
6	June 9	3980	21° 23′ N.; 158° 19′ W.	Surface.	Various sizes. One with bell 33 mm. high, with no gonads. One with bell 67 mm. high, with small gonads only 4 mm. wide.
2	June 17	4009	21° 50′ 30″ N.; 159° 15′ W.	Surface.	One with bell 61 mm. high, with no gonads. Other small, with no gonads.

Genus PERIPHYLLA Steenstrup.

Periphylla Steenstrup, Acta Musci Hafniensis, 1837. Haeckel, Syst. der Medusen, p. 418, 1880. Maas, Résult. Camp. Sci. Albert Ier, Prince de Monaco, fasc. XXVIII, p. 44, 1904.

Generic characters: Periphyllidæ with 4 interradial marginal sense organs; with 16 (8 double) marginal lobes; with 12 solid tentacles, three between each successive pair of marginal sense organs.

Periphylla dodecabostrycha Haeckel.

Pl. III, figs. 5, 6.

Chrysaora (*Dodecabostrycha*) *dubia*, Brandt, J. F., Mem. Acad. Imp. St.-Pétersbourg, Sci. Nat., VIe sér., par. 2, tom. 2, 4me liv., p. 387, 1838, taf. XXIX. Haeckel, E., Syst. der Medusen, p. 421, 1880. Vanhöffen, E., Acalephen der Plankton-Expedition, p. 10, taf. II, fig. 1, 1892; Die Acraspeden Medusen, Wissen. Ergeb. der Deutschen Tiefsee-Expedition, "Valdivia," bd. III, p. 23, 1902. Maas, O., Scyphomedusen der Siboga-Expedition, 11 monogr., 1903, p. 6, taf. II, fig. 15; taf. XII, fig. 107; Mem. Mus. Comp. Zool. at Harvard Coll., vol. XXIII, No. 1, 1897, p. 64, taf. XI, fig. 1. Résultats Campagnes Scientifiques Albert Ier, Prince de Monaco, etc., fasc. XXVIII, p. 47, pl. V, fig. 36–37, 1904.

There are five specimens of *Periphylla* in the *Albatross* collection which appear to be *Periphylla dodecabostrycha* in three different stages of growth. The bell of the smallest medusa is 55 mm. high and 50 mm. wide at the tentacular zone (fig. 5, pl. II); while that of the largest is 100 mm. wide and only 70 mm. high (fig. 6, pl. II). Another somewhat damaged specimen of intermediate size is 45 mm. wide and about 45 mm. high. As the color, shape of lappets, etc., remain the same in all of these

specimens, and they come from identical, or almost identical, localities, there is reason to suppose that they represent merely stages of growth of *Periphylla dodecabostrycha*.

Figures 5 and 6, plate II, show the shape of the bell in the smallest and largest medusa, respectively. It may be seen that when the medusa is small the bell is higher than it is wide, whereas in the large medusa the bell is wider than it is high in the proportion of about 10 to 7.

All of the specimens obtained by the *Albatross* are quite deeply pigmented with brownish-purple, the pigment extending into the entodermal pouches of the lappets, and being so dense in the zones of the circular and the radial muscle fibers that it is difficult to see the form and position of the gonads by looking through from the outside of the bell.

Attention should be called to the fact that it seems hazardous to attempt to separate the various species or races of *Periphylla*, on the ground of relative height and width of the bell, for the form of the bell appears to change with age, becoming flatter and relatively wider as the medusa grows larger.

Both Maas (1904) and Vanhöffen (1902) agree that in *P. hyacinthina* the bell is relatively high and the pigmentation so dense that the gonads can not be seen by looking through the walls of the bell; whereas in *P. dodecabostrycha* the bell is flatter, its apex is blunter, and the pigmentation is lighter, so that the gonads may be seen more or less clearly by looking through the bell walls from the outside. However, in 1892 (taf. I, fig. 1), Vanhöffen gives a figure of "*P. hyacinthina*" from life showing the gonads clearly visible through the hyaline walls of the pedal zone.

Similarly in *P. regina*, Maas (1897, taf. X) shows the bell only faintly pigmented, whereas Vanhöffen (1902), in his report upon the Scyphomedusæ of the *Valdivia* expedition, shows it quite densely pigmented. Vanhöffen (1902) concludes that the species described by Fewkes, Haeckel, etc., can be reduced to three, namely, *P. hyacinthina* Steenstrup (1837), *P. dodecabostrycha* Brandt (1838), and *P. regina* Haeckel (1880).

The species are separated mainly upon color differences, shape of bell, and size at the time of the development of the gonads. It should be borne in mind, however, that these are characters which are most apt to be individually a locally variable in medusæ. For example, the varieties and local races of *Cyanea* or *Obelia* along the Atlantic coast of the United States differ one from the other in just such characters; yet any attempt to separate them specifically leads to confusion, for there are intermediate forms that prevent such classification. The case may be somewhat similar with *Periphylla*, and it is possible that all of the so-called species may in the end prove to be local races of one and the same form. However this may be it has been demonstrated by the Plankton, *Valdivia*, and *Siboga* expeditions that the Periphyllidæ are truly deep-sea medusæ, living at or near the bottom, and only upon rare occasions coming to the surface.

It seems unnecessary to redescribe *Periphylla dodecabostrycha* after the excellent studies and figures of Vanhöffen and Maas, but for the sake of clearness we will enumerate some of the characteristic features of its anatomy.

Specific characters: Bell higher than wide in young, wider than high in well-grown medusæ. Four interradial marginal sense organs, 12 solid tentacles, and 16 spatula-like marginal lappets. Exumbrella with a deep annular furrow, and below this a zone of 16 thick gelatinous pedalia, one for each marginal sense organ and tentacle. The pedalia are separated one from another by deep longitudinal clefts which extend from the annular furrow downward through the mid region of each lappet. Thus the pedalia alternate in position with the lappets. Each sense organ contains a protruding sac of otoliths, and a mass of entodermal pigment. (See Maas, 1903, taf. II, fig. 15.)

There is a zone of well-developed circular muscles in the subumbrella above the bases of the tentacles. This zone is divided into 16 parts by 16 selvages. Each selvage extends down the middle of a lappet so that the reflected halves of each pair of adjacent lappets are connected by circular muscle fibers. There are 8 longitudinal areas of radial muscles in the subumbrella above the zone of circular muscles. Four of these are radial and 4 interradial. Eight V-shaped gonads alternate in position with the 8 strands of longitudinal muscles, the open ends of the V's being uppermost. The central stomach is wide, and is continued into the gastro-vascular space of the bell in 4 elongate radial clefts, the edges of which are lined with gastric cirri. A partial septum extends down the middle line of each lappet, and the gastro-vascular space forms a canal around this septum. The medusa is more or less deeply pigmented with purple-brown, which is especially well developed in the entoderm, but is sufficiently translucent to allow one to see the gonads showing faintly through the bell walls. The annular furrow and the clefts between the pedalia of the exumbrella exhibit brown ectodermal pigment. The tentacles are white, while the gelatinous substance of the bell is hyaline.

Record of Hawaiian specimens.

No. of specimens.	Date.	Station.	Geographical position.	Depth.	Remarks.
				Fathoms.	
4	1902. June 17	4005	Ukula Point, Kauai Island...	577–480	One small specimen 55 mm. high, 50 mm. wide. No gonads. Figured. Three large specimens about 100 mm. wide, 70 mm. high. With gonads. One figured.
1	June 24	4029	.....do.....	478–453	Medium size, about 45 mm. wide, 45 mm. high. Damaged.

P. dodecabostrycha is widely distributed over the floor of the deep oceans, especially in tropical regions of the Pacific. It has been found off the west coast of Mexico, off the coast of Chile, in the Indian Ocean, in the Malay Archipelago, even in the Guinea Stream, off the west coast of Africa, by the *Valdivia*, and in the Mediterranean, by the Prince of Monaco.

In small specimens a short, usually curved, diverticulum of the gastro-vascular space extends upward into the gelatinous substance of the apex of the bell. As was suggested by Vanhöffen, this may indicate that the medusa develops through an alternation of generations. This canal appears in our figure 5, plate II of the young medusa. Unfortunately we know nothing of the development of the Periphyllidæ.

Genus ATOLLA Haeckel.

Atolla, Haeckel, Syst. der Medusen, p. 488, 1880. Fewkes, Report U. S. Commis. Fish and Fisheries for 1884 (1886). Vanhöffen, Ergeb der Deutschen Tiefsee-Expedition, bd. 3, 1902, p. 22 etc. Maas, Résult. Campagnes Sci., etc., Prince de Monaco, fasc. XXVIII, 1904, p. 48.

Generic characters: Collaspidæ with numerous (16 or more) tentacles which alternate with an equal number of marginal sense organs. The marginal lappets are twice as numerous as the tentacles, or marginal sense organs. The pedalia of the tentacles arise from a zone higher up upon the sides of the exumbrella than do the pedalia of the sense organs.

Atolla alexandri Maas.

Pl. III, figs. 10, 11; Pl. II, fig. 7.

Atolla alexandri Maas, O., Mem. Mus. Comp. Zool., vol. XXIII, 1897, p. 81, taf. XI, fig. 2, taf. XIV, figs. 4, 5. Agassiz and Mayer, ibid., vol. XXVI, 1902, p. 156.

Four specimens of *Atolla*, all belonging to the species *alexandri*, were found by the *Albatross*, and we present life-size drawings of the largest specimen.

In *A. alexandri* we find, occupying the center of the exumbrella, a smooth-edged lenticular-shaped disk. This raised central portion of the exumbrella is about one-half as wide as the medusa itself. Thus in a medusa 64 mm. wide the central convexity is 33 mm. wide. The outer edge of this raised center is smooth, simple, and annular, and wholly lacks the radial folds and furrows seen in other species of *Atolla*. A deep annular groove encircles the outer edge of the central disk. Immediately beyond this groove lies the zone of tentacular pedalia. In a medusa 64 mm. in diameter these pedalia are each 5.5 mm. wide, and each one of them supports a short tapering tentacle about 13 mm. long. These pedalia are partially separated one from the other by deep radial clefts which extend radially inward midway between the tentacles for about one-half the distance from the outer edges of the pedalia to the annular furrow. In a medusa 64 mm. wide there were 32 pedalia and the same number of tentacles. Intermediate and alternating with the pedalia are the bases of the lappets. These lappet-stalks arise at a level lower than the pedalia of the tentacles, and each one bears a single marginal sense organ flanked by a pair of elongate marginal lappets. The sense organs, tentacles, and tentacular pedalia are thus equal in number each to each, while the marginal lappets are twice as numerous. Thus in the medusa 64 mm. in diameter there are 32 pedalia, 32 tentacles, 32 marginal sense organs, and 64 marginal lappets (see fig. 11).

Turning now to the subumbrella side of the medusa, we find at the center a more or less miter-shaped dark-colored manubrium, at the extremity of which we find the mouth surrounded by 4 long, narrow tapering lips. (See fig. 10, pl. III.)

There are 8 bean-shaped gonads in the subumbrella wall. They are adradial in position, and lie about half way between the center and the circular muscle. Each gonad, in a medusa 64 mm. in diameter, is 9 mm. long and 5 mm. wide.

The circular muscle band in the same medusa is a ring of powerful strands 2 mm. wide and 51 mm. in inside diameter. The whole subumbrella surface is strongly convex, the wing-muscle encircling its outer edge. The disk is 9 mm. thick in a medusa 64 mm. wide, its general form being that of a double convex lens.

The arrangement of the peripheral canals of the gastro-vascular space is shown in figure 7, plate II. Simple, straight canals extend radially outward to the sense organs, and to the bases of the tentacles, and these are joined by looping vessels that extend into the bases of the lappets. There are no fused plates in the radii of the tentacles, such as are described by Maas in *Atolla bairdii* (1904, Résultats Campagnes Scientifiques, etc., Prince de Monaco, fasc. XXVIII, p. 51, pl. IV, fig. 34).

The tentacles appear to increase with the growth of the medusa; thus, calling the diameter of the medusa the width across the ring muscle of the subumbrella, we find that a medusa 16 mm. in diameter had 23 tentacles, one of 16.5 mm. had 24, one of 43 mm. had 33, and one of 54.5 mm. had 32.

Record of Hawaiian specimens.

Number of specimens.	Date	Station.	Geographical position.	Depth.	Remarks.
	1902.			*Fathoms.*	
1	June 17	4005	Ukula Point, Kauai Island...	577–480	Figured specimen; 32 tentacles.
1	....do...	4005	.....do	577–480	8 gonads beginning to appear; 23 tentacles.
1	July 16	4154	Alia Point Light, Hilo Bay...	26–50	No gonads apparent; 24 tentacles.
1	Aug. 12	4177	Kawahioa Point.....	451–319	No gonads seen; damaged specimen; 33 tentacles.

Genus PELAGIA Péron et Lesueur.

Pelagia, Péron et Lesueur, Tableau des Méduses, 1809. Haeckel, Syst. der Medusen, p. 504, 1880.

Generic characters: Pelagidæ with 8 adradial tentacles alternating with 8 marginal sense organs; 16 marginal lappets.

Pelagia panopyra Péron et Lesueur.

Pl. II, figs. 3, 4.

Pelagia panopyra Péron et Lesueur, Tableau des Méduses, p. 349, nr. 64, 1809. Brandt, J. F., Mem. Acad. Imp. des Sci. St. Petersbourg, VI^e^ ser., par. 2, Sci. Nat., tom 2, 4 ^ème^ liv., 1838, p. 382, pl. XIV, fig. 1, pl. XIVa, fig. 1–5. Haeckel, Syst. der Medusen, p. 509, 1880.

The disk is 45 mm. wide and about one-half as high as a hemisphere. The aboral, or exumbrella surface, is sparsely covered with blunt, wart-like, rounded protuberances. There are 8 hollow tentacles, each about three-fourths as long as the bell diameter. Eight marginal sense organs alternate with the 8 tentacles. There are 16 blunt marginal lappets. The mouth is at the center of the lower surface or subumbrella of the disk. It is surrounded by 4 curtain-like palps, which extend downward from the 4 radial corners of a throat tube. The throat tube is about 15 mm. long, and the curtain-like palps each about 35 mm. long. The central stomach is a flat disk-like cavity, which gives rise to 16 radiating pockets, or cavities, which extend outward the tentacles and sense organs. These pouches are completely separated one from another by septæ, which extend outward to the middle of the lappets. Sixteen powerful radial muscles extend outward through these septæ, near the subumbrella surface. The gonads are 4, complexly folded, outpocketing, in the 4 interradial edges of the stomach. There are 4 wide, shallow pits in the floor of the subumbrella. These are interradial and extend inward from the region of the gonads toward the center of the disk. The tentacles are pink, and the aboral surface of the disk is sprinkled with purple pigment. The gonads are deep purplish pink.

This species appears to be widely distributed over the middle and western parts of the tropical Pacific. Three specimens were found by the *Albatross* among the Hawaiian Islands.

Record of Hawaiian specimens.

Number of specimens.	Date.	Station.	Geographical position.	Depth.	Remarks.
	1902.			*Fathoms.*	
1	June 13	Waimea ..	Kauai Island	Surface...	Figured specimen 45 mm. in diameter.
1	May 13	3929	23° 19′ N.; 166° 54′ W	.....do	41 mm. in diameter.
1	June 17	4010	Between Kauai and Oahu..	.....do	14 mm. in diameter. No gonads visible.

HYDROMEDUSÆ.

Genus SOLMARIS Haeckel.

Solmaris Haeckel, Syst. der Medusen, p. 355, 1880.

Generic characters: Solmaridæ with a numerous and variable number of tentacles alternating with the equally numerous marginal lappets. Stomach a simple lenticular cavity, without pouches extending into the lappets. Gonads more numerous than the lappets and appearing as a ring of wart-like sacs in the subumbrella wall beyond the periphery of the stomach.

Solmaris insculpta, new species.

Pl. III, figs. 8, 9.

Specific characters: The bell is about $\frac{2}{3}$ as high as a hemisphere and, in large specimens, is about 24 mm. in diameter. The rim of the bell consists of 14 lappets, the adjacent edges of which are joined by a velar web. The exumbrella of the bell is sculptured in high relief. A prominent ridge extends down the middle line of each lappet, and this median ridge is flanked by two others which extend down near the edges of the lappet. The valleys between the ridges are well marked, and the ridges themselves are rendered quite conspicuous by violet pigment which extends along their crests.

There are 14 relatively stiff tentacles which alternate with the lappets, arising from the sides of the bell at a zone about one-quarter of the distance from the rim of the bell to the apex. The entodermal cells of these tentacles are disk-like and their entodermal cores project inward to the edge of the stomach. The tentacles are all of the same size, and are a little longer than the bell radius.

Preservation in formalin had destroyed the otoliths, but it appears that there are three marginal sense organs to each lappet, or 52 in all.

The stomach is a flat lenticular cavity, and the mouth a simple round opening. There are 42 oval, pouch-like gonads arranged in a circle around the edge of the stomach. Of these gonads 14 occupy intertentacular radii, while the remaining 28 flank the sides of the tentacle bases. The gonads are regularly spaced in a circle at the periphery of the stomach; not grouped into more or less separate clusters as in *Solmaris godeffroyi* Haeckel, of Samoa. Moreover *S. godeffroyi* lacks the complex sculpturing of the exumbrella seen in *S. insculpta*, and there are but 24 gonads, arranged in 8 sets of 3 each (see Haeckel, 1879, Syst. der Medusen, p. 355, taf. XIX, fig. 2).

Specimens of *S. insculpta* preserved in formalin show gonads of a faint purplish brown color, while the sculptured ridges of the exumbrella are violet.

Forty specimens were obtained by the *Albatross* among the Hawaiian Islands, all being found on the surface. Small individuals have 12 or 13 tentacles, but the normal number in large specimens appears to be 14. Type no. 21799 U. S. National Museum.

Record of Hawaiian specimens.

Number of specimens.	Date.	Station.	Geographical position.	Depth.	Remarks.
	1902.			*Fathoms.*	
2	Mar. 17	3797	31° 55′ N.; 136° W.	Surface	One small, one of medium size.
1	May 6	3913	Diamond Head, Oahu Island	do	Large.
2	May 11	3927	21° 31′ N.; 161° 55′ W	do	Do.
2	May 13	3929	23° 19′ N.; 166° 54′ W	do	Do.
3	May 15	3930	25° 07′ N.; 171° 50′ W	do	Small, medium size.
6	May 16	3932	Laysan Island	do	Some small, some large.
8	June 17	4009	Between Kauai and Oahu islands	do	One specimen was 28 mm. in diameter, and was the largest found by the Albatross.
1		4037	West coast of Hawaii	do	Medium size.
15	(?)	(?)	(?)	(?)	Well preserved large specimens, no label.

CTENOPHORÆ.

Genus HORMIPHORA L. Agassiz.

Generic characters: Cydippidæ with hook-shaped tentacle-sheaths placed close by the sides of the stomach. These sheaths open to the outside at the level of the funnel or between this and the apical sense organ. The tentacles have side branches, some of which are usually hand-shaped.

Hormiphora fusiformis Moser.

Pl. III, fig. 12.

Lampetia fusiformis Agassiz and Mayer, Mem. Mus. Comp. Zool., vol. XXVI, 1902, no. 3, p. 171, pl. 13, figs. 59, 60.
Hormiphora fusiformis Moser, F., Die Ctenophoren, Siboga-Expeditie, monog. 12, 1903, p. 12, Leiden.

This ctenophore was first described by Agassiz and Mayer from the Marquesas and Paumotu Islands, where it was obtained by the *Albatross* in 1900.

Moser (1903) rightly calls attention to the fact that it approaches much more nearly to the genus *Hormiphora* than to *Lampetia*. However, it possesses the feathered tentacles seen in *Lampetia* and *Pleurobrachia*, and lacks the characteristic hand-shaped appendages of the tentacles seen in *Hormiphora*. The body is also far more elongate than in any previously described *Hormiphora*. It has, however, the peculiar hooked tentacle sheaths close to the sides of the stomach, such as are found in *Homiphora*. It seems probable that when the Ctenophoræ come to be revised it will be found convenient to place this form in a new genus. This, however, we hesitate to do at present.

Specific characters: The body is spindle-shaped, about 40 mm. long and 15 mm. wide in the tentacular diameter. It exhibits considerable lateral compression, the tentacular diameter being about half again as long as the thickness in the opposite direction. The apical sense organ contains a spherical mass of transparent otoliths. The eight meridional vessels extend not quite two-thirds the distance down the sides of the body from the apical sense organ. They are straight and end blindly below. There are about 40 combs of cilia upon each meridional vessel. These extend along almost the entire length of each canal. The two lateral tentacles arise from long, narrow clefts, close to the sides of the stomach. These tentacle sheaths, or clefts, open upon the sides of the body about midway between the apical sense organ and the base of the funnel, and they extend down close to the sides of the stomach about one-quarter the length of the animal above the mouth. The tentacles are highly contractile and are provided with simple lateral filaments, such as are seen in the genus *Pleurobrachia*, except that they are much less numerous. The mouth is a narrow slit, capable of no great expansion. The stomach is long, flat, and narrow, and it gives rise to two simple, straight-edged canals which extend down either side of the stomach to very near the level of the mouth opening. The funnel canal, and the radiating vessels that connect the stomach with the meridional vessels are broad and straight. The tentacles are milky in color, the stomach faint, steely blue, and all other parts of a glassy clearness.

Record of Hawaiian specimens.

Number of specimens.	Date.	Station.	Geographical position.	Depth.
	1902.			
3	Mar. 18	3799	Between Enben Bank and Kaiwi Channel	Surface.
2	Apr. 15	3880	Molokini Islet	Do.
1	June 17	4010	Between Kaui and Oahu	Do.

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EXPLANATION OF PLATES.

PLATE I.

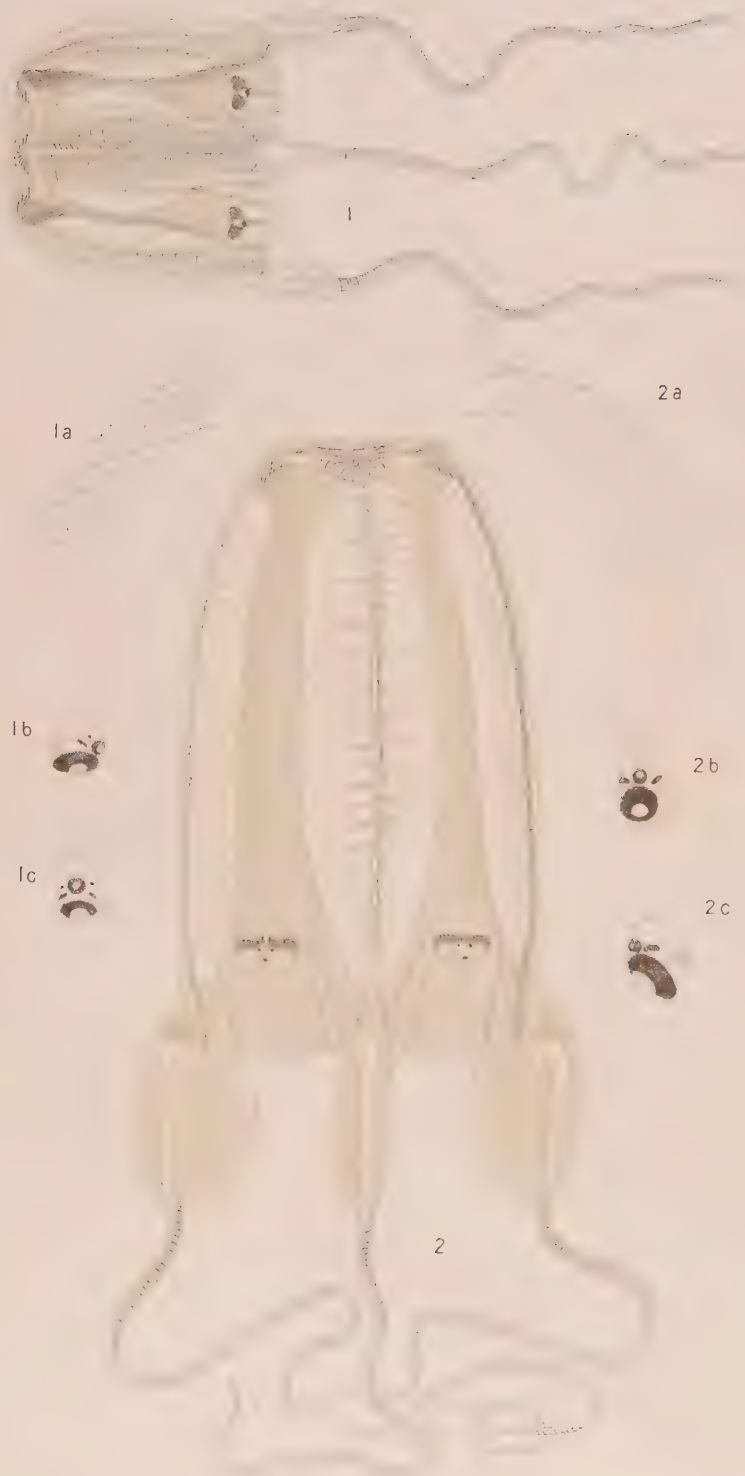
FIG. 1. *Charybdea rastonii* Haacke. Natural size, full grown.
1a. *Charybdea rastonii.* View of a quadrant of the velarium, showing the velar canals.
1b. *Charybdea rastonii.* Side view of sense-club.
1c. *Charybdea rastonii.* View of sense-club from the inner side. The eyes are arranged so as to perceive objects within the bell-cavity.
2. *Charybdea moseri.* New species; natural size, full grown.
2a. *Charybdea moseri.* A quadrant of the velarium showing the traight, unbranched, velar canals.
2b. *Charybdea moseri.* Sense-club seen from the inner side.
2c. *Charybdea moseri.* Side view of sense-club.

PLATE II.

FIG. 3. *Pelagia panopyra* Péron et Lesueur. Oral view, natural size, of mature medusa.
4. *Pelagia panopyra.* Side view of mature medusa.
5. *Periphylla dodecabostrycha* Brandt-Haeckel. Side view of young medusa, showing the relatively high, sharp-pointed bell. Natural size.
6. *Periphylla dodecabostrycha.* Side view, natural size, of mature medusa, showing the flat, low-domed bell of the adult.
7. *Atolla alexandri.* View of the peripheral canals of the gastro-vascular system.

PLATE III.

FIG. 8. *Solmaris insculpta*, new species. Oral view, twice the natural size.
9. *Solmaris insculpta.* Side view.
10. *Atolla alexandri* Maas. Oral view, natural size.
11. *Atolla alexandri.* Aboral view, showing sculpturing of the exumbrella.
12. *Hormiphora fusiformis* Moser = *Lampetia fusiformis* Agassiz and Mayer. Twice natural size.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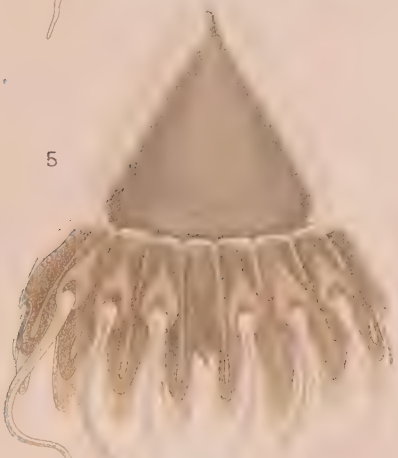

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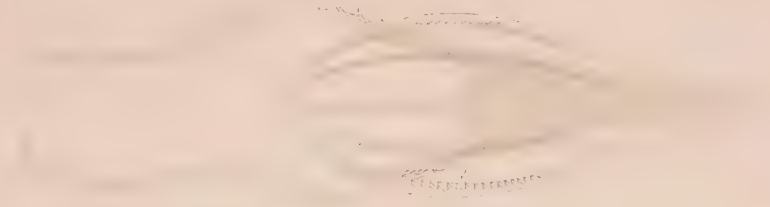

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POLYCHÆTOUS ANNELIDS OF THE HAWAIIAN ISLANDS COLLECTED BY THE STEAMER ALBATROSS IN 1902.

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INTRODUCTION.

The polychætous annelids here described were collected by the U. S. Fish Commission steamer *Albatross*, in 1902, in the vicinity of the Hawaiian Islands. In addition, a single specimen (*Terebella* sp.) from Pago-Pago, Samoa, and a number of specimens collected in 1903 off the coast of California are described in this report. The families represented and the number of new and old species found in each are as shown in the accompanying table:

Family.	Old species.	New species.	Family.	Old species.	New species.
Amphinomidæ	5	1	Staurocephalidæ	1	
Aphroditidæ	2		Eunicidæ	6(+1?)	
Polynoidæ	6	5	Goniadidæ		1
Acoetidæ		1	Glyceridæ	1	
Sigalionidæ	2		Cirratulidæ	2	
Nephthydidæ	1(?)		Maldanidæ	1(?)	
Phyllodocidæ	3		Hermellidæ	1	1
Alciopidæ	2	2	Terebellidæ	4(+3?)	4
Hesionidæ	1	1	Sabellidæ	1	3
Syllidæ	2		Serpulidæ	2(+1?)	
Nereidæ	3		Tomopteridæ	1(?)	

Much of this material was very badly preserved, and it was often difficult to get normal structures for study. It is probable, therefore, that some species here described as new may belong really to previously known species. My chief endeavor has been to describe them with clearness, so that they may be recognized if they appear in later collections.

Family SYLLIDÆ.

Genus TRYPANOSYLLIS.

Trypanosyllis gemmipara (?) Johnson.

Trypanosyllis gemmipara Johnson, The Polychæta of the Puget Sound Region, Proc. Boston Soc. Nat. Hist., vol. 29, no. 18, p. 405, pl. 7, figs. 72 to 76.

Fragments of three specimens, probably of this species. Setæ have rather longer terminal joints than in Johnson's description, and the esophagus is shorter. Esophagus with 8 rather than 10 teeth.

Collected at station 4070, 45 to 52 fathoms, on a bottom of fine gray sand, and from station 4551, in the vicinity of Monterey Bay, Cal.

Genus **EUSYLLIS** Malmgren.

Eusyllis tubifex Gosse.

Fragments of specimens agreeing with McIntosh's description of this species (McIntosh, Challenger Report, vol. XII, p. 190).

Collected at station 4551, vicinity of Monterey Bay, Cal.

Family HESIONIDÆ.

Genus **CASTALIA** Sars.

Castalia oculata, new species.

Head roughly 4-sided, broader end in front. A pigmented depression in anterior median area (fig. 1). Eyes, two pairs, anterior ones very large, distinctly bilobed, the larger lobe anterior; posterior eyes less prominent, oval.

Tentacles about as long as head, slender, tapering; palps with broad basal and slender terminal joints, about two-thirds as long as head. In the specimen figured they were curved down over the pharynx, and thus appear shorter. Proboscis when protuded (fig. 1, *p.*), with a median dorsal lobe lying just in front of the prostomium (fig. 1, *m. l.*).

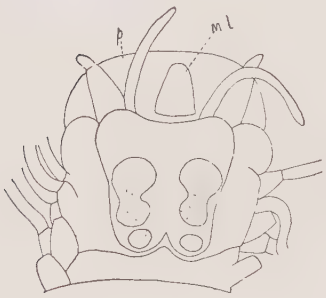

FIG. 1.

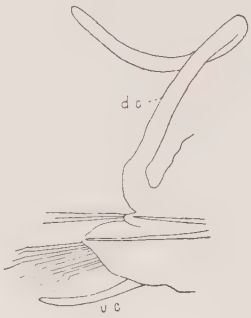

FIG. 2.

FIG. 3.

Castalia oculata, new species. (1) Head, × 7; *m. l.*, median lobe; *p.*, proboscis. (2) Parapodium, × 7; *d. c.*, dorsal cirrus; *v. c.*, ventral cirrus. (3) Compound seta, × 183.

Median portion of head with edges rounded. On either side from base of this rounding the surface slopes downward and outward to bases of tentacular cirri. These are 8 on a side, approximately equal in size.

Somites, 17, with dorsal and ventral cirri, but the seventeenth without setæ; dorsal cirrus long, with surface more or less regularly ringed, but apparently not a true jointing; ventral cirrus extending considerably beyond end of parapodium.

Parapodium with large ventral and small dorsal lobe (fig. 2). Setæ of former large, compound, with teeth at apex of terminal portion, and a row of minute denticulations along edge of latter (fig. 3). Basal portion with fine longitudinal lines running along it in an elongated spiral fashion; numerous transverse lines intersect these, dividing the surface into small quadrangular spaces; dorsal setæ very long, slender, and sharp-pointed, with numerous parallel transverse lines throughout their greater portion.

Length, 15 mm.; width, without parapodia, 5 mm. Collected at station 4066, 176 to 49 fathoms, on a rocky bottom.

Type no. 5200, U. S. National Museum.

Genus HESIONE Savigny.

Hesione pacifica McIntosh.

Hesione pacifica McIntosh, Report Challenger Expedition, vol. XII, p. 184, pl. XXIX, fig. 2, pl. XXXII, fig. 14.

McIntosh records that the tips of all setæ were broken in his specimens. Mine showed complete compound setæ (fig. 4). A noticeable feature is a reddish brown transverse band on the 2d setigerous somite.

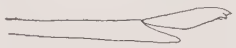

FIG. 4.—Compound seta of *Hesione pacifica*, × 183.

Collected at stations 3969, 15 to 16 fathoms, on a bottom of coarse sand, of shell, and coral; 3876, 28 to 43 fathoms, on sandy bottom; 4061, 24 to 83 fathoms, on coral, sand, and coralline nodules; and 4168, 20 to 21 fathoms, on coral, sand, and foraminifera.

Family POLYNOIDÆ.

Genus POLYNOE Savigny.

Polynoe magnipalpa? McIntosh.

Polynoe magnipalpa McIntosh, Report Challenger Exp., vol. XII, p. 118, pl. XII, fig. 6, pl. XIV, figs. 1, 6, pl. XVIII, fig. 5, pl. X A, figs. 5, 6.

A single specimen, probably of this species. The lateral tentacles were relatively larger, and the palps smaller than in McIntosh's specimen. He describes clavate papillæ on border of elytron. These are not shown in his drawing, and do not appear in the Hawaiian specimen.

Collected at station 3968, 14½ to 16½ fathoms, on bottom of coarse stone and coral.

Polynoe mirabilis McIntosh.

Polynoe mirabilis McIntosh, Report Challenger Exp., vol. XII, p. 121, pl. XVI, fig. 1, pl. XII A, figs. 9 to 11.
Oligolepis violacea Levinsen, Kara Havets, Copenhagen, 1886, p. 290, pl. 25.

McIntosh states that the "pedicels of nine pairs of scales exist in the specimen," and that "traces of two pairs of cirri occur on each side of the anus," thus implying that his specimens were entire. Of the Hawaiian specimens, none was entire; one had 25, and others 28 elytrophores on a side, with a total number of somites of over 70. In a personal communication Professor McIntosh tells me that while his description was correct as applied to his single, imperfect specimen, the form described by Levinsen is undoubtedly the same, and is described as having 25 bristle-bearing feet. In view of the similarities between these and McIntosh's description I am certain that they all belong to his species, and that the apparent lack of agreement in number of somites is due to the fact that none was complete.

McIntosh describes a filiform process on the inner anterior border of the head lobe, which he thinks may be the homologue of the antenna. Some of the Hawaiian specimens showed a similar process, but others had a slender tentacle a trifle longer than the head, and, like the cirri, with a slight swelling just behind the pointed apex. The "filiform process" is evidently merely a remnant of the antenna, of which the greater portion has broken away.

No elytra were present. Largest specimen 80 mm. long, 15 mm. wide, exclusive of parapodia. Width to tip of parapodium, 30 mm.

On the locality label was noted, "livid flesh pink or light beef pink."

Collected at stations 4028, 444 to 478 fathoms, on gray sand and globigerina ooze; 4022, 399 to 374 fathoms; 4113, 433 to 395 fathoms; and 4014, 399 to 362 fathoms, the three latter on coral, sand, and foraminifera.

Polynoe alba, new species.

Each lateral half of head pear shaped, with anterior portion prolonged to form base for tentacles (fig. 5); median tentacle filling entire space between laterals; whole head white, looking as if incrusted with a calcareous deposit, this much denser on bases of tentacles; all tentacles, except basal joints,

and tentacular cirri, lost on specimens; palps long, smooth, gently tapering to apex; proboscis 10 times as long as head, with 13 papillæ above and below; two strong, dark brown teeth above and below, with lighter colored plates on either side; dorsal surface flesh color, prominently marked with the white incrustation-like color found on the head. This is especially noticeable on parapodia, but is continued anteriorly, more or less irregularly across the entire surface. Behind about somite 14, elytra-bearing somites are free from white pigment, while somites between (those having a dorsal cirrus) are marked across the entire back by this white pigment, giving the middle of the body a very characteristic striated appearance.

Only a single elytron remained in either of the two specimens. This, the most anterior on the left side, was ovate, with outer edge rather narrow and of a dense white color; center of elytron with a number of white patches; rest of elytron transparent, edge entire. The elytron blends so well with the color of the rest of the body that it is not easy to see.

Most dorsal cirri had been lost; those remaining were slender, conical, extending only a short distance beyond end of parapodium. Ventral cirrus short, conical, situated about at middle of parapodium. Parapodium short as compared with body diameter, with apex divided into anterior and posterior rounded lobes (fig. 6). Setæ all of one kind, simple, apex flattened and slightly bent, and bearing on concave surface, two rows of very delicate plates looking, under low power, like two series

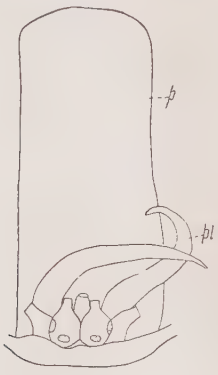

FIG. 5.

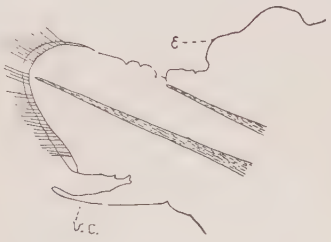

FIG. 6.

FIG. 7.

Polynoe alba, new species. (5) Head, × 5; *p.*, proboscis; *pl.*, palp. (6) Parapodium, × 12; *e*, elytrophore; *v. c.*, ventral cirrus. (7) Seta, × 57.

of sharp spines. Each plate has a narrow base and broader distal portion, the latter cut into minute teeth; whole plate curved, with concave surface next to shaft of seta (fig. 7, from side).

Head 1 mm. in diameter; somite 2–4 mm. in diameter. One somite from the middle of the body measures about 6 mm.

Collected at Honolulu Reefs. Type (no. 5201, U. S. National Museum) an incomplete specimen; head 1 mm. broad; somite 2–4 mm. broad; a somite from near middle of body about 6 mm. broad.

Polynoe lucida, new species.

Head rather broader than long, markedly iridescent (in alcohol) with two pairs of eyes, anterior rather larger than posterior (fig. 8); lateral lobes of head prolonged into bases of attachment for lateral tentacles; lateral tentacle 5 or 6 times as long as head, with acute tip, and subterminal swelling; median tentacle with broad base, filling space between bases of lateral; like lateral in form, but longer and a little stouter; base of each tentacle tipped with brown, the median having the deeper color. Palps had been broken off; a loose one in the bottle, undoubtedly belonging to this specimen, was broad at base, tapering gently to an acute tip.

Elytrophores on somites 2, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 26, 29, 32, 35, etc. Only about 50 somites present, and elytra were absent from most of these; where present they cover nearly the whole dorsal surface. Except for pigment patches, elytra very transparent, body wall showing clearly

through them. Elytron from middle of body broadly ovate, with entire edge (fig. 9); point of attachment to elytrophore visible from above as a colorless area. This nearly or quite surrounded by a band of dark brown pigment, from which a band of pigment extends to the edge of the elytron which lies on the mid-dorsal line. This pigmented area varies in width from a narrow band to a broad patch, from whose anterior end scattered pigment spots may extend; posterior edge more sharply defined, convex. A median longitudinal brown line along the dorsal surface of the body, this more prominent posteriorly. Parapodia long, posterior ones longer than transverse diameter of body; at the outer dorsal angle each is prolonged into equal anterior and posterior ear-like processes, between which setæ emerge (fig. 10). A large aciculum extends into main lobe, with a smaller one going toward dorsal surface.

Setæ all of one kind, long, simple, terminal portion slightly enlarged and bent. On convex surface of bent portion are two rows of very delicate thin plates, more or less alternating with one another; under low power these look like two rows of spines; under higher power each "spine" is seen to be a very thin plate, broader at its distal than at its proximal attached end. Owing to their transparency the precise form of these plates is difficult to determine. Their general form is very like setæ of *Polynoe alba*.

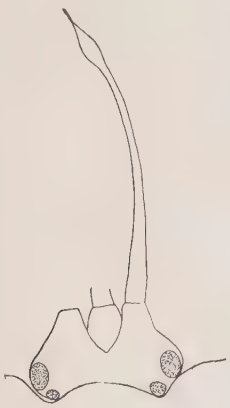

FIG. 8.

FIG. 9.

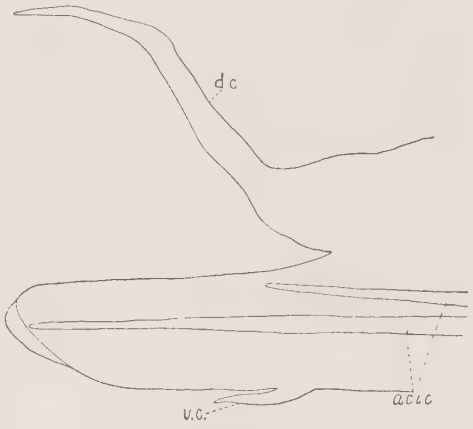

FIG. 10.

Polynoe lucida, new species. (8) Head, ×9. (9) Elytron, ×12. (10) Parapodium, ×12; *v. c.*, ventral cirrus; *d. c.* dorsal cirrus; *acic.*, aciculæ.

Collected at station 4062, 83 to 113 fathoms, on a bottom of corals, volcanic sand, and shells.

Type (no. 5202, U. S. National Museum) an incomplete specimen of 60 somites; length, 37 mm.; width of head, 1.5 mm.; width of body at somite 6 with parapodia, 7.5 mm., without parapodia, 4.5 mm.

Polynoe spicula, new species.

Head oval, width at base of ceratophores about equal to that of posterior edge; greatest length about equal to greatest width, prolonged anteriorly on either side into bases of ceratophores, the latter deep brown with colorless apex; antennæ slender, length to extreme tip about equal to that of head and ceratophore. At about two-thirds of distance from base to tip there is a slight enlargement, beyond this the organ tapers rapidly to a very delicate tip; basal half brown in color, with a brown band at base of swelling; remainder white. Ceratophore of medium antenna completely filling space between those of lateral ones, extending only to a short distance beyond them and colored like them; terminal portion like that of lateral antenna, but a trifle larger; eyes two pairs, the anterior slightly the larger, and situated on the lateral surface of head; posterior pair near posterior border, and slightly nearer median line than anterior; palps extending about as far as median antenna, gently tapering, abruptly narrowing to apical portion, which is slender and nearly uniform in diameter throughout; tentacular cirri like antennæ in form and color.

Elytra 12 pairs; first ovate in outline, anterior and lateral margins with a relatively very broad fringe of cylindrical processes, other margins smooth. Surface of elytron divided into angular areas of various sizes, the largest nearest the middle. These are indicated by their brown color, the lines between being colorless. From the center of each arises a hard, dark-brown spine. Toward the fringed border these spines are relatively short, the ends of some showing subdivisions into 3 or 4 points. Largest spines 10 to 14 in number, on large central and dorsal areas. These in height may be very nearly equal to width of area. Other elytra more nearly reniform, those of same side overlapping, while those of opposite sides overlap for more than one-fourth of their length; concealed portion white, remainder brown, due to brown areas mentioned above. Two or three posterior pairs of elytra especially noticeable for the size of the dorsal spines.

FIG. 11.—Seta of *Polynoe spicula*, × 280.

Most dorsal cirri had been lost; those which remained were like tentacles in form and color; ventral cirrus acutely conical, with slender terminal prolongation reaching about to end of parapodium. Parapodium cylindrical, obliquely truncated at apex, with posterior and anterior edges prolonged into flat vertical lobes, the former slightly the longer of the two. Two large dark-brown aciculæ protrude slightly beyond apex of parapodium.

Ventrally there is a tuft of about 20 very long setæ with broad basal portions; apex slightly narrowed and tapering to terminal hook. Beginning about three-fourths of length of free portion of seta is a double row of fine lateral teeth (fig. 11 from side, showing one row), each with a narrow base and a flattened apex, these teeth increasing in size toward end of seta, and the row terminated by a single stout tooth, showing no secondary denticulations. Stalk of seta with prominent longitudinal striations extending as far as large terminal tooth. Dorsally a bundle about equal in number to those of ventral bundle, of much shorter, more translucent setæ, which taper uniformly to their apex, and show on either side a close-set row of minute plates each with narrow base, and broad, finely toothed apex. These overlap one another from base of seta toward apex, and show very little, if any, decrease in size toward apex of seta.

Collected at station 4420 and from station 4551, vicinity of Monterey Bay, Cal.

Type (no. 5203, U. S. National Museum) a specimen 18 to 20 mm. long and 5.5 mm. in width, from station 4551.

FIG. 12. FIG. 13. FIG. 14. FIG. 15.

Polynoë mutilata, new species. (12 and 13) Anterior seta, × 183. (14 and 15) Posterior seta, × 183.

Polynoe mutilata, new species.

Head rounded, with a trace of a single anterior lateral eye remaining; median tentacle very slender; antennæ slender, tapering, about twice as long as head, marked with an irregular black patch near the base; tentacular cirri in form much like antennæ and marked with similar black patch, the cirri varying in size, smallest about twice size of antenna, largest twice the size of smallest; palps long, smooth, gently tapering to a blunt point.

Elytra very small and inconspicuous, anteriorly not covering dorsal surface of parapodium. Posteriorly they cover parapodia, but leave whole median area of body uncovered. Elytra thin, nearly circular in outline, with edge entire and no noticeable surface markings. Whole body as well as elytra pale yellow in color, so that elytra are not prominent.

Anterior parapodia, e. g. second, shows a very delicate aciculum in the notopodial region, and a very stout one in the neuropodial. From the notopodial region protrudes a tuft of very long, fine,

thread-like setæ. At dorsal and ventral angles of neuropodium is a tuft of long setæ with slender bases, their terminal portion slightly flattened, at first broader than the base, tapering gently to the long, acutely pointed, wavy, terminal portion. A double row of teeth, looking in profile like a single row of denticulations (fig. 12), in face showing as a row on either side. Dorsally only a few of these (2 in specimen drawn), ventrally 10–12.

Between the two bundles of finer setæ was a single row of a few large setæ, prominent on account of their size and brownish-yellow color. Each has a broad base (fig. 13), slightly widening and then rapidly tapering to the apex, which is bluntly rounded and provided with a tuft of stiff hair-like bristles at the end. Indefinite and poorly defined longitudinal and transverse markings appear on the surface of these setæ. Ventral cirrus rather stout, gently tapering to blunt end.

Parapodium of 16th-somite shows ventrally a tuft of setæ like figure 13 and dorsally a smaller tuft of setæ like figure 14. Here the terminal portion has the appearance of having been teased out into fine fibrils. Through median portion of parapodium a single row of very stout setæ (fig. 15). At the apex each is prolonged into a long spine, which bears near its base a row of shorter spines. On one side edge of seta apex seems to be entire, on opposite side is a shallow indentation, from bottom of which arise numerous small spines.

Apparently setæ like figure 14 appear first on somite 7. From the fact that I find only a very few setæ like figure 15 on anterior somites it is possible that those represented in figure 13 are merely mutilated specimens really belonging to this variety. I am unable, however, to discover in them any indication of the terminal depression from which the spines arise. Setæ with numerous fine processes at the ends are especially numerous on somites behind about the 20th.

Fragments of anterior ends of about half a dozen specimens, contained in thick-walled mud tubes, outer surface of latter covered with deposit of thick brown mud. None were complete, and none were well preserved.

Collected at station 3892, 328 fathoms, and from station 4027, 319 fathoms; both on a bottom of fine gray sand.

Type (no. 5204, U. S. National Museum) an incomplete specimen from station 4027; length of 28 anterior somites, 17 mm.; greatest width, including parapodia, 5 mm.; width of head, 1 mm.; length of protruded proboscis, 7 mm.

Genus HARMOTHOE Kinberg.

Harmothoe haliaeti McIntosh.

Harmothoe haliaeti McIntosh, Report Challenger expedition, vol. XII, p. 96; British Annelids, pt. II, Ray Society, p. 336, pl. XXXVIII, fig. 27, pl. XXXIX, fig. 1, 2, 3.

In the first of the above publications McIntosh gives no illustrations, and in the second figures only setæ. The other references which he quotes were not accessible to me. I have identified the specimens from the character of the setæ and from McIntosh's description of the head. (See fig. 16.)

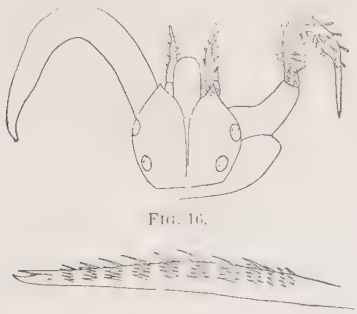

FIG. 16.

FIG. 17.

FIG. 18.

Harmothoe haliaeti. (16) Head, × 12. (17) Seta, × 280. (18) Elytron, × 23.

In the setæ, however, it seems to me that the spiny protrusions on the sides are really rows of distinct teeth (fig. 17), and not flat plates with denticulated ends, as McIntosh figures. In the Challenger report McIntosh describes the elytra as with smooth edges. In the second paper he quotes Haswell [a],

[a] Polychaeta Liverpool District, p. 231, pl. XIII, fig. 2.

who describes them as having densely fimbriated borders. The specimens from Hawaii agree with the latter character (fig. 18).

Collected from station 4077, 99–106 fathoms, on fine coral sand and foraminifera, station 4098, under essentially similar conditions, and station 3972, 100–374 fathoms, on coarse sand and coral.

Harmothoe hirsuta Johnson.

Harmothoe hirsuta Johnson, Preliminary Account of the Annelids of the Pacific Coast, Proc. Cal. Ac. Sci., 3d ser., vol. I, p. 182, pl. VI, figs. 27, 28, pl. VII, fig. 38, pl. VIII, figs. 53, 53a, 53b, 53c.

A single specimen lacking all head appendages and all dorsal cirri. I have identified it as this species from the character of the head (though the anterior eyes are larger than in Johnson's figure 38), from the structure of a single elytron, which shows the characteristic branched tubercles, and from the setæ, in which respect the specimen agrees perfectly with Johnson's description.

Collected at station 4312 in the vicinity of San Diego, Cal.

Harmothoe tuberculata, new species.

Owing to the incompleteness of the single specimen in this collection, I am unable to write a very complete description, and have given the above specific name only provisionally.

All cirri, antennal elytra, and tentacles lost; 13 pairs of elytrophores, on somites 1, 2, 5, 7, etc.; total length, 17 mm.; greatest breadth, 5 mm.; on median dorsal line a very prominent tubercle in each somite. Beyond the statement that antennæ are inserted below the level of tentacle, nothing can be said about the character of the head. A single tentacular cirrus shows a subterminal swelling.

Neuropodium and notopodium distinct in the parapodia. (Fig. 82.) Neuropodium rounded at apex, with anterior face covered with short finger-shaped branchiæ. Most dorsally placed branchia four times as long as the others (b, fig. 82). Neuropodial setæ few, shaft broad, abruptly widening toward apex, narrowing again rapidly to gently curved tip. Shaft marked by very fine longitudinal striations. Running transversely across both faces of terminal enlargement are a number of rows of fine, tooth-like projections continued as far as base of terminal hook.

The label reads: "Commensal in actinostome of *Brisinga.*"

Type no. 5205, U. S. National Museum, 16 mm. long, collected at station 4177, on bottom of fine gray sand, in 451 fathoms.

Genus GATTYANA.

Gattyana senta Moore.

Gattyana senta Moore, Some new Polynoidæ, with a list of other Polychaeta from North Greenland waters, Proc. Phila. Acad. Nat. Sci., vol. LIV, May, 1902.

A single specimen from station 4551, in the vicinity of Monterey Bay, California. The specimen was incomplete, of only 25 somites, and measured 25 mm. The only point of difference between it and Moore's description was that nephridial papillæ begin on sixth instead of ninth somite.

Genus IPHIONE Savigny.

Iphione muricata (Savigny).

Polynoe muricata Savigny, Systeme des Annelides, p. 21, pl. II, fig. 1, 1809.
Iphione muricata Grube, Annulata Semperiana, p. 21, 1818.

Collected at eleven different stations—nos. 3847, 3848, 3850, 3873, 3876, 3935, 3962, 3968, 3987, 3999, 4147. These had bottoms of coarse sand or gravel, broken shells or corals, and the depths were from 14–79 fathoms. Station 3999 is recorded as 7–148 fathoms, with no indication as to the precise depth where these specimens were found. Apparently they do not ordinarily live below 50 fathoms.

Family ACOETIDÆ.

Genus EUPANTHALIS McIntosh.

Eupanthalis oahuensis, new species.

Of the three specimens (none entire) in this collection, only one retained any trace of antennæ. Head roughly rectangular in outline, with anterior margin a little narrower than posterior; anteriorly on either side a rounded protuberance (sessile eye?), but no trace of pigment appeared (in alcoholic material); tentacles slender, a little shorter than head, arising from ventral surface of head. Owing to the poor preservation of the specimens, this is all that can be said concerning the head. What seemed to be the stump of a median tentacle appeared between the bases of the lateral. Palps long, gently tapering, smooth, diameter at base rather more than one-half that of head.

Width at head, including anterior parapodia, 3 mm. This gradually increases, reaching, at somite 12, a diameter of 6 mm., but narrows again to about 3 mm. at somite 20, continuing at this width throughout the remainder of the fragment.

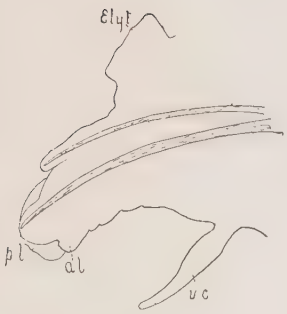

Fig. 19.

Fig. 20.

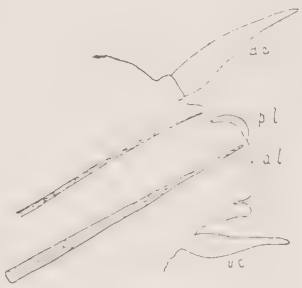

Fig. 21.

Fig. 22.

Fig. 23.

Eupanthalis oahuensis, new species. (19) Second parapodium, × 25; *elyt.*, elytrophore; *a. l.* and *p. l.*, anterior and posterior lobes; *v. c.*, ventral cirrus. (20) Seta from second parapodium, × 165. (21) Third parapodium, × 25; lettering as in figure 20. (22) Seta from third parapodium, × 165. (23) Seta from posterior somites, × 260.

Elytrophores on somites 2, 4, 5, 7, 9, 11, etc. Elytra very delicate, transparent, anteriorly barely more than covering dorsal surface of parapodium, behind about the twentieth somite, extending nearly to median dorsal line. Edge of elytra smooth, with no processes or lobings.

Second parapodium elongated, the large neuropodium with a bilobed anterior (fig. 19, *a. l.*), and a broader, more rounded, posterior lobe (*p. l.*). Notopodium very small, appearing as a small lobe on dorsal surface of neuropodium. Dorsally is a large elytrophore, *elyt.*, and ventrally a lanceolate cirrus, *v. c.* A large aciculum extends into the neuropodium, while a much smaller one terminates in the notopodium. From the base of the notopodium arises a bundle of very long, delicate setæ, extremely attenuated at the tip. In the specimen figured were 12 of these. The larger ones have serrated, the smaller smooth, edges. Setæ of ventral bundle much larger, their bases extending about as far as base of aciculum, and from $\frac{1}{4}$–$\frac{1}{2}$ the diameter of this; protruding portion narrower, flattened, and sharp pointed, the whole bent into the form of an elongated crescent; on concave side are 2 rows

of sharp spines, which appear as a single row when seen from the side as in figure 20. Dorsal setæ of this bundle much larger than ventral, but differing from them in no other important respect.

Third parapodium much shorter than second, squarely truncated at the end (fig. 21); posterior lip broad, rounded, anterior lip bilobed; dorsal cirrus with basal and long, lanceolate, terminal joint; apex extending more than half length of cirrus beyond apex of parapodium. Notopodium a small elevation on dorsal surface of neuropodium. Aciculæ as in second parapodium. Dorsally a bundle of very fine setæ, like those described for notopodium of second parapodium. On dorsal and ventral surfaces of neuropodium are other setæ like those described above, the ventral bundle containing much the larger number; between these a row (5 in number in parapodium figured) of stout yellow-colored setæ, with curved, bluntly pointed ends. At the apex a bundle of fine bristle-like processes, while from one side of apex arises a long, delicate, colorless spine, with two rows of minute processes along its basal portion (fig. 22).

On following somites, beginning with seventh in one specimen and tenth in another, is another form of seta, found in bundles of 2 or 3 on dorsal surface of parapodium. These have a moderately stout inner axis, with a dense bundle of delicate radiating spines at the apex (fig. 23).

With the exception of the delicate setæ first described, which disappear early, all the above forms of setæ are continued into the posterior portion of the body. The shafts of the setæ increase considerably in length, so that they stand out prominently from the sides of the body.

Fiber glands are present, and the black chitinous ropes secreted by them are prominent in all somites behind the seventh or eighth.

Dental apparatus a long, gently curved maxilla on either side, colorless except for the apex, which is light brown, and on either side a dental plate with about 16 denticulations.

Collected at station 3892, 328 fathoms, on a bottom of fine gray sand. Type no. 5206 U. S. National Museum.

Family SIGALIONIDÆ.

Genus PSAMMOLYCE Kinberg.

Psammolyce fijiensis McIntosh.

Psammolyce fijiensis McIntosh, Report Challenger Expedition, vol. XII, p. 148, pl. XXI, fig. 6, pl. XXII, fig. 4, pl. XXIV, fig. 6, pl. XIII A, fig. 18.

This was originally described by McIntosh from a single incomplete specimen. In the present collection was one specimen, also incomplete, undoubtedly of this species, though differing somewhat from McIntosh's description.

Only the head and about 38 anterior somites remained; length of this portion 11 mm. Proboscis protruding to distance of 4 mm., being about as long as first 4 somites. On either side, above and below, at the end, are 11 papillæ. Four large teeth in pharyngeal cavity. When pharynx is protruded the head is rotated upward so that the anterior pair of eyes, mentioned by McIntosh as invisible from the dorsum, are indistinctly seen through the flattened transparent basal portion of the tentacle.

Terminal portion of tentacle absent, as was one palp. Other palp long, smooth, gently tapering to a blunt point, the tip extending beyond the end of the protruded pharynx, in this differing from McIntosh's specimen, in which the palps were very short.

Elytra cover rather less than half of dorsal surface; inner third of each and dorsal body surface between them densely covered with minute sand grains; anterior edge of each elytron, where it is overlapped by the one in front of it, and outer half of exposed area free from sand.

Some somites show, in addition to the compound setæ described by McIntosh (pl. XIII A, fig. 18), a few having a similar general form, but more slender, paler, and with a longer terminal joint. A few of the larger setæ also show transverse rows of minute serrations near the end of the basal joint.

Collected at station 3847, 23 to 24 fathoms, on sandy and stony bottom.

Genus THALENESSA Baird.

Thalenessa oculata McIntosh.

Thalenessa oculata McIntosh, Report Challenger Expedition, vol. XII, p. 142, pl. XXI, figs. 1, 2, pl. XXIII, fig. 12, pl. XXV, fig. 3, pl. XIII A, fig. 11, 12.

I have identified this species from the description given by McIntosh, though his figures give little aid in determining the character of the head. His figure 1, plate XXI, looks as if the head had been drawn without removing the anterior pair of elytra, and neither this nor figure 2 shows either antennæ or tentacles. His description is, however, so clear that there can be no error in the determination. The compound ventral setæ may show more than two segments in the terminal portion. In the first seta-bearing parapodium I find as many as 9 of these terminal segments.

Collected at station 3833, 142–88 fathoms, on sand, pebbles, and broken shell; station 3955, 20–30 fathoms, on coral rock; station 3936, 79–130 fathoms, on broken shells and corallines, and station 4061, 24–83 fathoms, on coral sand, coralline nodules, and foraminifera.

Family APHRODITIDÆ.

Genus APHRODITA Linnæus.

Aphrodita echidna de Quatrefages.

Aphrodita echidna de Quatrefages, Anneles 1, p. 197. McIntosh, Report Challenger Expedition, vol. XII, p. 36, pl. VII, fig. 1, 2, pl. VI A, figs. 2–3.

The setæ of these forms differ somewhat from those described by McIntosh. The large dorsal setæ bend sharply at the end to form a terminal hook, and the ventral setæ of both kinds, instead of a thick basal and slender terminal, pilose portion, show a gradual narrowing from the basal to the terminal parts. The pilose patch leaves uncovered the extreme end, which protrudes as a gently curved, stout spine, resembling in this respect the setæ of *Iphione spinosa* (op. cit., pl. VIII, *A*, fig. 5). McIntosh states, however, that his figure was drawn from a specimen probably undergoing regeneration.

Just dorsal to the larger ventral setæ in some somites (I could not find them in all) is a bundle of delicate colorless setæ. Each has a strong lateral tooth near its end, and shows a distinct toothing beyond that (fig. 24).

FIG. 24.—Seta from *Aphrodita echidna*, × 183.

Elytra may have more or less of a fulvous coating above and below, or may be entirely free from it. The felt formed by fine threads covering the dorsal surface is filled with débris of various sorts, containing diatoms, radiolaria shells, and small annelid sand tubes.

Collected at stations 4081, 202–238 fathoms, on a bottom of gray sand, and 4082, 256–283 fathoms, on a bottom of fine volcanic sand.

Genus LÆTMONICE Grube.

Lætmonice producta wyvillei McIntosh.

Lætmonice producta Grube, Monatsber. k. Akad. zu Berlin, 1877, p. 512.
Lætmonice producta var. *wyvillei* McIntosh, Report Challenger Expedition, vol. XII, p. 44, pl. VII, fig. 3, pl. IV A, figs. 9–11.

Dorsal spines nearly all broken or lost, so that it was difficult to get one intact for examination. They agree with McIntosh's description, except that they show numerous nodules along the shaft, which he does not figure. The villous character of the ventral surface is not as marked as in the specimens described by McIntosh.

Collected at station 4004, 773–645 fathoms, on a bottom of brown mud and rock; station 4038, 689–670 fathoms, on a bottom of gray mud and foraminifera; station 4036 on bottom of fine gray sand, in 687 fathoms.

Family PHYLLODOCIDÆ.

Genus PHYLLODOCE Savigny.

Phyllodoce sanctæ-vincentis McIntosh.

Phyllodoce sanctæ-vincentis McIntosh, Report Challenger Expedition, vol. XII, p. 166, pl. XXVII, fig. 9, pl. XXXII, fig. 8, pl. XIV A, figs. 14, 15.

Three specimens were in this collection, one from station 3810 (211–53 fathoms, on a bottom of fine coral sand) being somewhat larger than the one described by McIntosh, having a width of 4 mm. in the widest part. The eyes, also, were much larger than in McIntosh's figure, and I could not find the terminal row of "warts" which he describes for the proboscis. There is a row of 16 papillæ around the proboscis aperture.

Other specimens from station 4098 (95–152 fathoms, on a bottom of coral sand, foraminifera and radiolaria) agreed more closely in size of body and character of proboscis with McIntosh's description than did the above, though the differences in the form of dorsal and ventral cirri in different parts of the body were less than he indicates. McIntosh describes the species as having "large blackish eyes," but figures rather small ones. The present specimens agree more nearly with his description than with his figure.

Phyllodoce tenera Grube.

Phyllodoce tenera Grube, Annulata Semperiana, p. 97, 1878.

So far as I can tell from Grube's description, this specimen belongs to his species. The ventral cirri are filled with a material which turns yellow in preserving fluid, thus presenting a sharp contrast to colorless portion of remainder of body.

Collected at station 3812, 6½ fathoms, on a bottom of coral and coral sand.

Genus ANAITIS Malmgren.

Anaitis tenuissima Grube.

Phyllodoce tenuissima Grube, Annulata Semperiana, p. 95, 1878.

Grube's description is not accompanied by figures, but so far as I could determine from his text this specimen belongs to this species. Grube describes tentacular cirri on 3 somites. This would bring it under the genus *Anaitis* rather than *Phyllodoce*.

Collected at station 3940, 59–70 fathoms, on a bottom of white sand and broken shells.

Family ALCIOPIDÆ.

Genus VANADIS v. Greef.

Vanadis minuta, new species.

Body small, first 21 somites measuring 8 mm.; eyes prominent, light brown in color, broader than any part of anterior region of body; diameter across eyes 2 mm. Seen from above, head shows two prominent eyes, corneal areas not visible in this view; a bridge of tissue extends across from one eye to the other, with a rounded lobe (tentacle?) on its anterior edge (*t.* fig. 25); anteriorly a pair of lanceolate marginal tentacles (*a. t.*, fig. 25). Ventrally, head shows longer tentacles below the lanceolate ones. Only one was present in the specimen (*p. t.*, fig. 26); large corneal areas look downward and outward; between the eyes a series of longitudinal foldings extend down into mouth (fig. 26). Posterior portion of head broad, and extending out like a shallow saucer, in which eye-bearing portion seems to be held. Laterally this is prolonged into a cirrus on either side, with a distinct joint at its base, which extends out under the eye (*c*, fig. 26).

First somite behind head with a cirrus on either side (fig. 26); second somite with similar but shorter cirri; third somite broader, with longer cirrus, which was present only on one side (fig. 26); fourth somite behind head, with large cylindrical appendages, almost as prominent as eyes (*S. A*, figs. 25 and 26); each bears on outer edge a small nipple-like protrusion. Two following somites have par-

apodia (lost on one side in the specimen) with a small, transparent, globular dilation at the base (figs. 25 and 26).

Parapodia very short as far as 6th somite, then elongated considerably, so that fully formed parapodium is almost as long as transverse diameter of the body. Dorsal and ventral lamellæ very irregularly distributed, so that I infer they must have been lost on many somites, and I can give no details as to on which somites they first appear. Parapodium from middle of body with lanceolate dorsal and ventral lamellæ, a cirrus extending from apex of setigerous portion, *f. c.* (fig. 27); each bears dorsally the brown segmental organ (*d. s. o.*), which is the only trace of color to be seen behind the

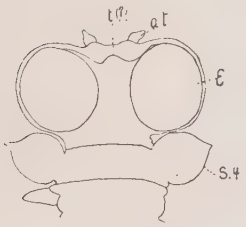

Fig. 25.

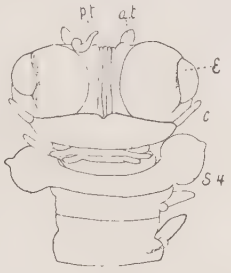

Fig. 26.

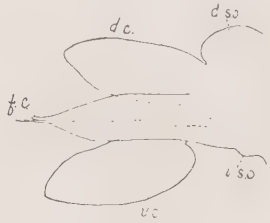

Fig. 27.

Fig. 28.

Vanadis minuta, new species. (25) Dorsal view of head, ×12.5; *e.*, eye; *s.* 4, fourth somite; *a. t.*, anterior tentacle; *t?*, median tentacle (?). (26) Ventral view of head, ×12.5; *c.*, cirrus of first somite; *p. t.*, posterior tentacle; other letters as in figure 25. (27) Parapodium, ×50; *d. c.* and *v. c.*, dorsal and ventral cirri; *d. s. o.* and *v. s. o.*, dorsal and ventral segmental organs; *f. c.*, cirrus at end of parapodium. (28) Seta, ×280.

eyes; anteriorly this organ is not present as a swelling, its location being indicated by a transversely arranged band of brown pigment; setæ longer than parapodium, compound, with terminal portion barely $\frac{1}{10}$ length of basal part (fig. 28).

This species is represented in the collection by one specimen from station 3802, taken in tow net 4 fathoms below surface, and one from 3797, under similar conditions. The latter was very badly preserved, but undoubtedly belongs to this species. The type (no. 5207 U. S. National Museum), from station 3802, measures 12.5 mm. to end of 14th setigerous somite.

Vanadis fusca punctata new species.

Body of medium size, head and first 22 somites together 13 mm. long. Head 2 mm. in diameter; 1st somite behind head nearly same width. Body then narrows gradually to somite 6, which is $\frac{2}{3}$ diameter of head. Later somites gradually widen to 2.5 mm. at somite 15 (measurements exclusive of parapodia). Fragments from posterior part of body twice as wide as this, but these measurements possibly not reliable, as the body had the appearance of having swollen under the influence of reagents. Color anteriorly a very light brown (in preserving fluid). Posteriorly, color entirely lost, except for segmental glands on posterior dorsal surface of all parapodia. These are dark brown in color, and are very prominent.

Head with large eyes, corneal surfaces directed outward and a little downward (fig. 29). The specimen from which figure 29 was drawn was turned a little to the left, so that right corneal area shows from above. A narrow bridge connects the two sides of the head. In front of this, on a slight elevation, is a single median tentacle. Two pairs of anterior tentacles (fig. 29 and fig. 30, dorsal pair only shown in fig. 29). Corneal surface of eye white, remainder dark brown.

On ventral surface of head eyes separated by deep fissure (fig. 30). Buccal frill divided into a median and two lateral portions. Lateral portions each with a stout cirrus (fig. 30). Following somite with a small dorsal and larger ventral cirrus. Next somite with large dorsal and small ventral cirrus. No trace of proboscidean tentacle in the specimens.

Proboscis 11 mm. long when extruded, widening gradually toward the end, with very abrupt widening at extreme end. On either side of this trumpet-shaped end, one edge is drawn out into a flattened, curved, horn-like process with end pointed and bent backward. Edge of opening between these processes thrown into irregular folds. Inner surface of proboscis longitudinally plicated.

Parapodium with broadly lanceolate dorsal and ventral lobes, dorsal larger than ventral, and standing out from the parapodium more prominently. A single terminal cirrus extends considerably beyond the apex of the aciculume (fig. 31).

Setæ numerous, forming a broad fan, a few on dorsal and ventral surfaces somewhat smaller than the others. Setæ compound, terminal joint very small, arising near end of basal portion, as in figure 28, of *Vanadis minuta*. Many setæ show transverse wrinkles at places where they are bent, indicating that they are hollow and their thin walls have collapsed at these places.

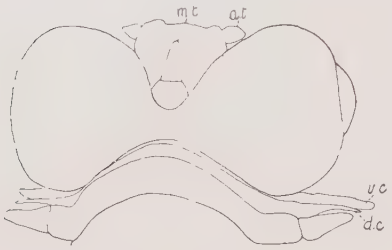

FIG. 29.

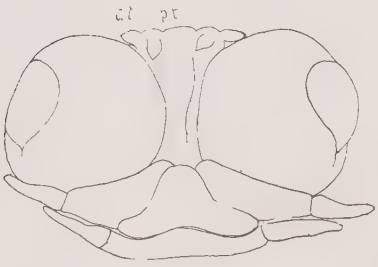

FIG. 30.

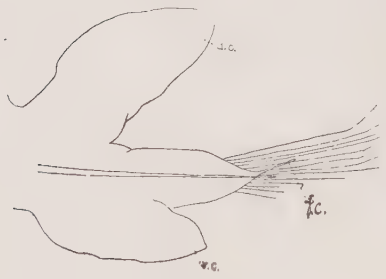

FIG. 31.

Vanadis fusca punctata, new species. (29) Dorsal view of head, × 11; *a. t.* and *m. t.*, anterior and median tentacles; *v.-c.* and *d. c.*, ventral and dorsal cirri. (30) Ventral view of head, × 11. (31) Parapodium, × 18.5: lettering as in figure 27.

Two fragments with heads, and a number from posterior portion of body, taken at station 3889, surface. Other fragments from station 3797, surface, and 4082, 220–238 fathoms, on a bottom of gray sand.

Type no. 5208, U. S. National Museum, a specimen 13 mm. long (incomplete), from station 3889.

Genus GREEFIA (NAUPHANTA) v. Greef.

Greefia oahuensis McIntosh.

Greefia oahuensis McIntosh, Report Challenger Expedition, vol. XII, p. 182, pl. XXVIII, figs. 5, 6, 7, pl. XXXII, fig. 11, pl. XV A, fig. 4.

The specimens agree more closely with McIntosh's description than with his figures. He describes dorsally "a short, flattened tentacle of a somewhat ovate form." This is clearly seen in the specimens, but does not appear in his figure 6. Color varies from light brown to deep purple, dorsal lamellæ of parapodia colorless. Ventral "segmental glands" not very prominent.

Collected at surface at stations 4190, 4011, 3980, and 4188, the latter affording only fragments from the posterior end.

Greefia quadrioculata McIntosh.

Alciopa (?) *quadrioculata* McIntosh, Report Challenger Exp., vol. XII, p. 176, pl. XXVIII, fig. 8, pl. XXIX, fig. 7.

Fragments of a single specimen. I have put it in this genus because of the character of the setæ, which are compound, slender, with a very slender terminal portion attached on one side a little behind the end of the basal portion, as is characteristic of *Greefia*. McIntosh described the head, but had no setæ, and while he put his specimen in the genus *Alciopa*, he noted a general resemblance to *Greefia*. In the peculiar eye structure, this specimen agrees with McIntosh's.

Collected at station 4190, surface.

Family TOMOPTERIDÆ.

Genus TOMOPTERIS Eschscholtz.

Tomopteris sp.

Three specimens, one large and fairly well preserved, and two small and very badly preserved. Length of smaller 3.5 mm.; of larger, exclusive of terminal portion, 14 mm.

Larger specimen shows head lobe on one side drawn out into point; on other side this point is broken off; first cirrus slender, short, with acute apex; second cirrus with spine, about equal to parapodial region of body in length. Parapodial region 14 mm. long, with 17 pairs of parapodia. Terminal smooth portion about 10 mm. long. Two broad plates at end of each parapodium, but these not well

enough preserved for description. Brain faintly bilobed, with dark-brown eyes. No trace of parapodial eyes.

These specimens correspond with no species described by either Vejdovsky [a], Apstein [b], or Greef [c], but since sexual differences are considerable in this genus, and the specimens are poorly preserved, I have thought it best not to attempt to give them a new specific name.

Collected at the surface at stations 3802 and 4037.

Family NEREIDÆ.

Genus NEREIS Cuvier.

Nereis (Platynereis) tongabutensis McIntosh.

Nereis tongabutensis McIntosh, Report Challenger Expedition, vol. XII, p. 212, pl. XXXIV, figs. 7, 8, 9, pl. XVI A, figs. 5, 6, 7.

One incomplete specimen from station 3968, 14½–16½ fathoms, on coarse sand and coral, and another from Pearl Harbor, Oahu. The label reads "Taken from mass of sponge."

Nereis sp.

Head broader than long (fig. 32), deeply cleft in front; anterior eyes much the larger, with lens facing anteriorly and outward; lens of posterior eyes facing dorsally. Antennæ and tentacular cirri lost. Palps very large.

First 8 parapodia with cirrus-like neuro- and notopodium. Dorsal cirrus about as long as parapodium, ventral cirrus nearly as long as dorsal. Behind somite 8 dorsal and ventral cirri become abruptly much shorter. Lobes of parapodia remain elongated for some somites, later shortening very decidedly.

Two kinds of setæ, one with short terminal joint having an apical hook with a "wing" and no lateral teeth, the other with very long, smooth, gently tapering terminal joint.

In the absence of information concerning antennæ, tentacular cirri, and jaw apparatus, I have not thought it wise to name this incomplete and possibly immature specimen. Width, including parapodia, 2 mm.; length of 8 somites, 3 mm.

A single specimen, retaining only the anterior end, from station 3968, 14½–16½ fathoms, on bottom of coarse sand and coral.

FIG. 32.—Head of *Nereis* sp., × 12.5.

Nereis kobiensis McIntosh.

Nereis kobiensis McIntosh, Report Challenger Expedition, vol. XII, p. 210, pl. XXXIV, figs. 3, 4, 5, 6, pl. XVI A, figs. 2, 3, 4.

Heteronereid phase. McIntosh described the atokous form only. I have identified these specimens, all of which were in the epitokous condition, from the structure of the paragnathi, in which respects they agree exactly with McIntosh's description; from the general character of the head, which agrees better with McIntosh's description than with his figure, and from the presence of peculiar hook-like setæ in the anterior, unmodified feet. The eyes were larger than in McIntosh's specimens (a modification consequent on the sexual phase), and he does not mention a spinous edge on the concave border of the falcate setæ.

Head of female with large eyes (fig. 33), in contact with one another; eye (in alcohol) deep purple in color, with white "lens," pointing anteriorly in anterior eye, upward and backward in posterior eye. Antennæ shorter than head, tapering gently to blunt point. Palps large, with stout basal and terminal joints. In the drawing (fig. 33) these are somewhat foreshortened, as the head in all cases had been bent toward the ventral surface. Tentacular cirri usually had been lost. Longest of remaining ones extended to sixth setigerous somite. Prostomium with a dorsal median prolongation, extend-

[a] Vejdovsky, Zeit. f. Wiss. Zool., bd. 31, p. 81.

[b] Apstein, Die Alciopiden und Tomopteriden der Plankton Expedition, 1900.

[c] Greef, Zeit. f. Wiss. Zool., bd. 32.

ing a short distance into an indentation in posterior dorsal border of prostomium. Some specimens showed irregularly distributed patches of reddish pigment on dorsal surface of head and along dorsal median line. None of the specimens were well preserved, such organs as cirri suffering much disintegration. The account of parapodia, etc., is based on what seemed to be the most normal individuals.

Second parapodium of female (fig. 34) with 4 lobes, one dorsal and one ventral, a long posterior and a short pointed anterior, into which extends the aciculum. Dorsal and ventral cirri with broad base and narrow apex, resembling one another in form, but the dorsal considerably the larger. Setæ compound, terminal joint toothed.

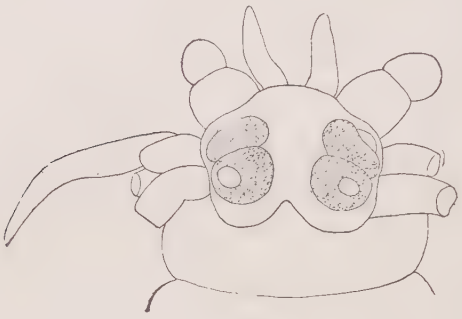

FIG. 33.

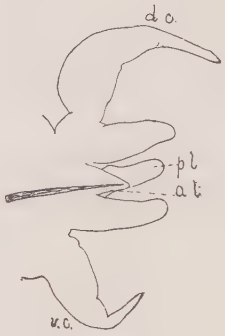

FIG. 34.

FIG. 36.

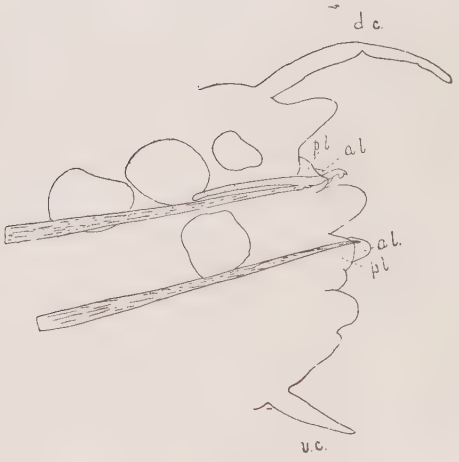

FIG. 35.

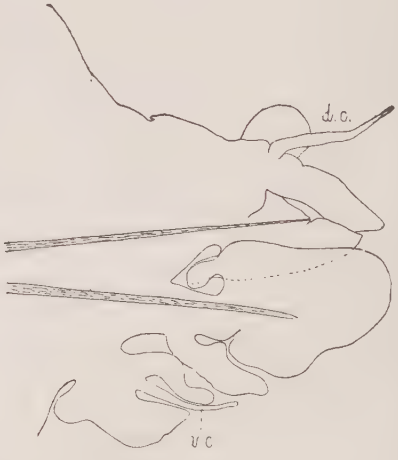

FIG. 37.

Nereis kobiensis. (33) Head, × 11. (34) Second parapodium of female, × 45; *d. c.* and *v. c.*, dorsal and ventral cirri; *a. l.* and *p. l.*, anterior and posterior lobes. (35) Eleventh parapodium of female, × 45; lettering as before. (36) Falcate seta from eleventh parapodium, × 280. (37) Twenty-fifth parapodium of female, × 45.

Eleventh parapodium of female with slender dorsal and ventral cirrus, and 3 blunt lobes; aciculæ projecting into spaces between these lobes; a shorter posterior and longer anterior secondary lobe at point where apex of aciculum reaches edge of parapodium (fig. 35). Near dorsal aciculum is a peculiar hook-like seta described by McIntosh. Dorsal setæ and dorsal half of ventral bundle with long, slender, toothed terminal joint. Ventral half of ventral seta bundle with few (only 1 in parapodium drawn) setæ like those of dorsal half; most of this bundle with "falcate" setæ. Basal joint with broad end, marked by longitudinally directed spiral lines, with transverse markings between the latter (fig. 36). Apical portion short, with narrow base, widening rapidly to strongly hooked tip, concave edge with about 10 long, narrow spines.

Modified parapodia begin at eighteenth to twentieth somite. Figure 37 shows one from somite 25. A rounded lobe appears at base of dorsal cirrus, and two irregular flattened expansions at base of ventral cirrus. Setigerous lobes elongated and broad, overlapping one another as shown in figure. Neuropodium and notopodium each with fan-shaped bundle of setæ. Setæ (fig. 38) with broad basal joint, into end of which fits the pointed end of the terminal joint; latter very broad, paddle-shaped, with row of minute teeth along one edge; basal joint with very fine transverse striations.

Female larger than male and may reach length of 37 mm.

Male usually not over 10 to 12 mm. long. Head and eyes like those of female. Modified parapodia like female except that dorsal cirrus is broader, and is lobed along ventral margin, as figured for heteronereis phase of other species. Anterior "unmodified" parapodia in general form like those of female, but important differences in the character of dorsal cirrus; that of first parapodium like female, but from here backward the parapodia gradually increase in size until they are very long on somite 7; here they show a thick, cylindrical basal portion, with broad flattened tip ending in an acute point

FIG. 38.

FIG. 40.

FIG. 39.

Nereis kobiensis. (38) Seta from twenty-fifth parapodium of female, × 68. (39) Seventh parapodium of male, × 68. (40) Seta from anterior somite of male, × 280.

(fig. 39). Setæ as in female except for a single stout dark brown seta in dorsal bundle. On eighth somite dorsal cirrus has usual form, this and following "unmodified" parapodia agreeing closely with those of female except that the lobes are shorter, and compound setæ are like those of somite 8 (fig. 40). There are apparently two pairs of long anal cirri, but on account of poor preservation, it is impossible to be sure on this point.

In both sexes anterior "unmodified" portion of body is filled with sex products, a complete degeneration of dissepiments and an almost complete disappearance of alimentary canal and body wall muscles having taken place. The sex products apparently arise in the posterior portion and are passed forward into the anterior region, where they are carried until ready to be discharged. Posterior region also well filled with sex products, but no very noticeable degeneration has appeared, except in the dissepiments, which are lacking.[a]

Collected in considerable numbers at stations 3851, 3812, 3921, 3843, 3823, 3905, 3850, 3821. Some were marked "surface," others not. It is probable that all were taken while swimming.

[a] Treadwell-Biological Bulletin, vol. IX, no. 4, September, 1905.

Family NEPHTHYDIDÆ.

Genus NEPHTHYS Cuvier.

Nephthys sp.

A single fragment of the anterior end of a very small specimen, 1.5 mm. broad in widest part, and of which the first 15 somites measured 3.5 mm., was collected at station 4442, at Harris Point, San Miguel Island, California. It was too much injured for identification.

Family AMPHINOMIDÆ.

Genus NOTOPYGOS Grube.

Notopygos megalops McIntosh.

Notopygos megalops McIntosh, Report Challenger Expedition, vol. XII, p. 18, pl. I, fig. 1, pl. II A, figs. 3 and 4.

A single specimen, 8 mm. long and 4 mm. broad, with 18 somites. The anus opens on the dorsal surface of somite 16. Station 3848, 44–73 fathoms, on a sandy bottom.

Notopygos labiatus McIntosh.

Notopygos labiatus McIntosh, Report Challenger Expedition, vol. XII, p. 19, pl. II, fig. 6, pl. IV, fig. 2, pl. II A, figs. 5, 6.

The anus opens dorsally on somite 22.

Collected from station "3851, surface." It seems very probable that there was some mistake in labelling, as *Notopygos* is not a surface form.

Genus EURYTHOE Kinberg.

Eurythoe pacifica Kinberg.

Eurythoe pacifica Kinberg, Öfvers. of K. Vet, Akad. Forh., 1857, p. 14. McIntosh, Report Challenger Expedition, vol. XII, p. 27, pl. II, figs. 3, 4, pl III, fig. 3, pl. II A, fig. 13, pl. III A, figs. 5–9.

Two imperfect specimens from station 4031, 27–28 fathoms, on a bottom of fine coral sand, and two, in a better state of preservation, from Honolulu Reef.

Genus CHLOEIA Savigny.

Chloeia flava Pallas.

Chloeia flava McIntosh, Report of Challenger Expedition, vol. XII, p. 8, pl. III, figs. 1, 3, pl. I A, figs. 7 and 9.

I have identified this species from McIntosh's description, these specimens differing from his mainly in coloration. They showed no fan-shaped patch of pigment near the dorsal cirrus, and instead of a row of "brownish purple" dots in each metamere, there are two continuous brown lines extending along the dorsal surface, one on either side the median plane. Some dorsal setæ are very long, slender, with a lateral spur, but with no teeth on the terminal portion. They are colored yellow as far as the lateral spur, but are colorless beyond this. Ventrally are similar, but stouter, colorless setæ.

Collected at stations 3846, 3847, 3848, 3874, and 3876, at depths varying from 21 to 60 fathoms, on sandy or gravelly bottom.

Genus EUPHROSYNE Savigny.

Euphrosyne heterobranchia Johnson.

Euphrosyne heterobranchia Johnson, Polychæta of Puget Sound Region, Proc. Boston Soc. Nat. Hist., vol. 29, no. 18, p. 402, pl. 6, figs. 60–66 a–c.

A single specimen, differing from Johnson's description only in the possession of 9 branchiæ on a side.

Collected at station 4551, in the vicinity of Monterey Bay, Cal.

Genus HERMODICE Kinberg.

Hermodice pennata, new species.

Head roughly quadrangular, anterior edge a trifle broader than posterior (fig. 41). The four large, light brown eyes and the thick median tentacle occupy nearly the whole dorsal surface of head. Anterior eyes a little larger than posterior, all prominent on dorsal view. Median tentacle relatively thick, situated about in center of rectangle, of which the eyes form the corners, tapering gradually to apex, which extends beyond oral lobe. Ends of tentacles and of cirri near the head looked as if either a collection of granular débris had adhered to them, or as if a terminal dilation, originally present, had broken into fragments during the preservation. Inner paired tentacles in form of an elongated cone, extending as far as base of median. Outer paired tentacles about same size as unpaired. Oral lobes prominent, rounded.

Caruncle in two parts. A short, triangular anterior portion, with transverse markings, its rounded base touching the median tentacle and covering over the anterior pair of eyes. Below and behind this the much broader posterior portion extending laterally so as to cover the whole dorsal surface of the first three somites between the parapodia. Greatest width of caruncle about middle of somite 3, tapering from there to end at posterior edge of somite 4. Caruncle composed of a central vertical lamella, and on either side lateral lamellæ, also vertical. Apparently there are typically 7 of these on a side. In the specimen figured the first one on the right had been lost, and the fifth on the left broken off, not far from the base. Those of the two sides are arranged in an alternating fashion. Along each runs an axial band of pink pigment (in alcoholic material) with numerous branches on either side, giving the whole caruncle a feathery appearance.

FIG. 41.—Head of *Hermodice pennata*, × 12.

Dorsal cirri with stout basal and slender conical terminal portion; ventral similar in form, but smaller; first ventral cirrus largest, those behind it diminishing gradually in size toward posterior end.

Gills on first somite as about six rounded lobes, arising from a common, rather broad, base. By segment 10, the number of these lobes has doubled. All gills with accumulation of pinkish brown pigment on dorsal surface, apex colorless.

Dorsal surface of each somite with numerous longitudinal pink bands extending across from one boundary to the other. Some are single, others branch, and others are incomplete, extending only a part of the way across.

Setæ of dorsal bundle long, very finely pointed; those of ventral bundle shorter, stouter, with fine denticulations along one edge.

Collected at station 4162, 24 fathoms, on a coral bottom. Type (no. 5209, U. S. National Museum), an incomplete specimen; length of head and first 15 anterior somites, 14 mm.; greatest width, 5 mm.

Family EUNICIDÆ.

Genus EUNICE Cuvier.

Eunice siciliensis Grube.

Eunice siciliensis Ehlers, Die Borstenwürmer, p. 353, pl. 16, 1864. (See Ehlers's paper for references to earlier literature.)

The wide distribution of this species is noteworthy. Described originally from a European locality, it has been collected at Porto Rico[a], and now appears in this collection from the Sandwich Islands. Collected at station 3849, at a depth of 73–43 fathoms, on a bottom of broken shells and corals; at station 3876, 28–43 fathoms, on a bottom of coarse sand, and at station 3940, 59–70 fathoms, on a bottom of sand and broken shells.

[a] Treadwell—Polychætous Annelids of Porto Rico, Bull. U. S. Fish Commission, vol. xx, 1900, p. 196.

Eunice vittata Delle Chiaje, var.? McIntosh.

Eunice vittata Delle Chiaje, var.? McIntosh, Report Challenger Expedition, vol. XII, p. 276, pl. XXXVIII, figs. 3, 4, 5, pl. XIX A, figs. 16, 17.

A single small specimen, from station 4021, on a bottom of coarse sand and foraminifera, at a depth of 286–399 fathoms.

Eunice collaris Grube.

Eunice collaris Grube, Annulata Semperiana, p. 158, pl. IX, fig. 3, 1878.

I have identified these specimens from the figure and brief description given by Grube in the above reference. At Hilo was collected an entire individual, very small, and evidently immature, and a portion from the middle of the body of a much larger specimen. The smaller, entire specimen corresponds with Grube's description in the form of the head and its appendages, and in the

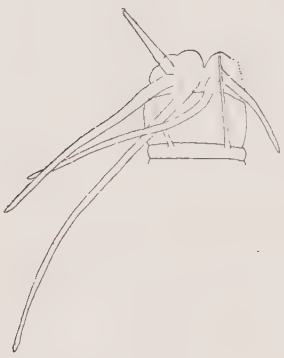

FIG. 42.

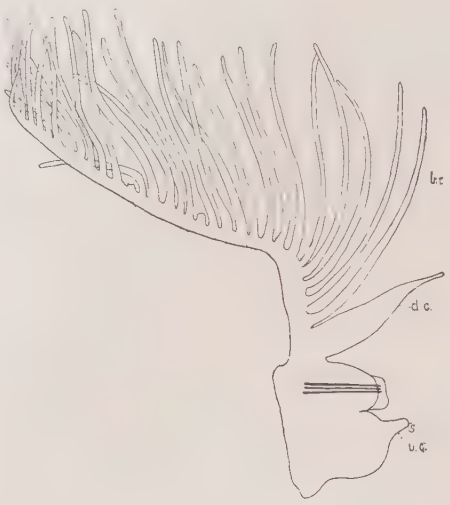

FIG. 43.

FIG. 44.

Eunice hawaiensis, new species. (42) Head, × 3.5. (43) Eleventh parapodium, ×10; *br.*, gills; *d. c.*, and *v. c.*, dorsal and ventral cirri. (44) Ventral seta. ×10.

fact that the dorsal surface is thickly studded with small, white spots. The gills begin on somite 17.

At Laysan were collected fragments of the anterior end of two individuals. Both were badly preserved, but one retained enough of the head and its appendages to admit of identification. The white spots were very faint, but the surface showed the brilliant iridescence mentioned by Grube.

Maxillæ rather strong, gently curved. Right and left dental plate each with 4 teeth. Right paired plate with 6, left with 5 teeth. Left unpaired with 3. This is, in each case, one less than was described by Grube for the corresponding plate. It is possible that he described as a tooth the projecting basal portion of each plate.

Dorsal setæ of two kinds, one long, sharp-pointed, tapering gently to their tip; in each somite a few (one to a somite?) comb-shaped setæ (brush-shaped setæ of McIntosh). Ventral setæ compound, basal portion heavy, with lateral denticulations on its distal end; terminal portion relatively small, with numerous denticulations along the edge, and with terminal and subterminal teeth, the "guard" barely extending beyond the latter; anteriorly, each parapodium with 2 aciculæ; toward posterior end, a third aciculum with hook-shaped end appears in the ventral part of the parapodium.

Eunice hawaiensis, new species.

Prostomium rather deeply bilobed, each lobe subdivided by two shallow grooves so as to present a 3-lobed appearance (fig. 42). Tentacles long, smooth, tapering uniformly to the apex, inner lateral reaching to eighth somite, median to fifteenth, outer lateral to second. Tentacular cirri slender, tapering, reaching to anterior border of prostomium. Eyes large, brown, in usual position.

Mandibles dark brown, with lighter colored edges. Each half of nearly uniform diameter throughout, curving gently outward at anterior end. Maxillæ stout, gently curved; left dental plate with 8 teeth; left paired with about 12, left unpaired with 8; right dental with 9, right paired with about 12. Color pale, with only toothed edges darker.

Gills begin on second parapodium, there rather small, with axis and 3 lateral branches; on third parapodium gill much larger, reaching mid-dorsal line, and with 12 branches; from fourth setigerous somite (sixth body somite) gills overlap in mid-dorsal line, this overlapping continuing until about the twenty-fifth somite, where gills begin to shorten until, on about somite 45, each has only 3 branches. On somite 50 gill is composed of only a small cirrus-like outgrowth from the dorsal cirrus. In its greatest development, the gill may have as many as 30 branches. (See fig. 43, of eleventh parapodium. Note the bend in the axis of the gill, which brings its terminal portion to lie parallel to the dorsal surface of the body.) Setigerous lobe with a rounded posterior, and a longer, nearly rectangular, anterior lobe. Into the latter extend the large aciculæ. Dorsal setæ long, gently curved, tapering gradually to a sharp point. At the point where curving begins, they are somewhat broader than elsewhere, with minute denticulations along the concave edge. Ventral setæ compound; basal portion long, expanded slightly at end, terminal portion narrow, sharp pointed at apex, with a terminal and a subterminal tooth (fig. 44). On posterior parapodia the teeth on the compound setæ are more prominent, and there are minute denticulations on both proximal and distal joints.

Type (no. 5210, U. S. National Museum) an incomplete specimen, retaining only the anterior 125 somites; length of this, 115 mm.; peristomium 4 mm. wide; body diameter increases gradually to about 50 mm. behind head, where it is 7 mm.; body (in formalin) a pale flesh color; gills white. Collected at station 4134, on bottom of fine coral and volcanic sand, at depth of 324–225 fathoms.

A second much smaller specimen, not more than one-quarter the size of the above, and with gills beginning on the fourth somite, was collected at station 4021, 286–399 fathoms, on a bottom of coral sand and foraminifera.

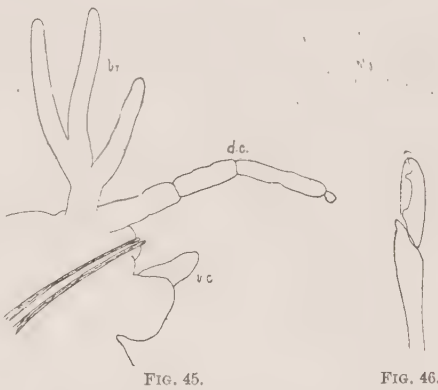

FIG. 45. FIG. 46.

Eunice interrupta, new species. (45) Twelfth parapodium, × 45; *br.*, gills. (46) Ventral seta, × 280.

Eunice interrupta, new species.

Prostomium broader than long, with a well-marked, though shallow, depression on the anterior border. Peristomium longer ventrally than dorsally, the median tentacle seeming to lie in a slight depression on its anterior edge. All tentacles moniliform, the constrictions being a little less distinct at the base than at the tip. Median tentacle extending to posterior border of ninth somite, inner laterals to somite 8, outer laterals to somite 3. Eyes large, brown, situated lateral to base of inner lateral tentacles and posterior to base of outer laterals.

Second somite one-third length of peristomium, its articulated cirri reaching to anterior border of eye. Dorsal cirrus of anterior parapodia noticeably moniliform, resembling the tentacles in this respect, becoming less noticeable, however, in succeeding somites, as in figure 45 of the twelfth parapodium, where dorsal cirrus shows merely a jointing. This jointing disappears at the twenty-second somite.

Gills first appear as a 1-branched appendage to the fifth parapodium; on the seventh they are 2-branched; on the eighth they are 3-branched, on the fifteenth they become 2-branched again; on the twenty-first there is but one. There is some variation in this gill arrangement, some somites in the middle of the body apparently lacking them. In the type a very small single branch is found in all somites, posterior to second.

Ventral cirri short and stout anteriorly, longer and narrower posteriorly. Two long, faintly articulated dorsal anal cirri. Ventral anal cirri, if originally present, had been lost.

Dorsal setæ long, simple, sharp-pointed at apex. Ventral setæ compound, basal portion with broad end, a single large tooth at the apex, and a row of fine denticulations down the side (fig. 46). Terminal

piece with tooth at apex and a second blunter tooth just behind this. "Guard" extending beyond teeth, finely serrated along its edge. One specimen of about 70 somites had a body length of 60 mm. and a greatest width of 4 mm.

Another, a sexually mature individual, showed the following conditions on one side of the body:

Somite vi, gill of 1 branch.
Somite vii, gill of 2 branches.
Somite viii, gill of 3 branches.
Somite xi, gill of 4 branches.
Somite xiii, gill of 3 branches.
Somite xx, gill of 2 branches.
Somite xxi, gill of 1 branch.

About the middle of the body the gills disappeared to reappear toward the posterior end.

Collected at stations 3834 and 3821 in surface hauls; 3850, 43–46 fathoms, on a bottom of coarse sand and broken shells; 3848, in essentially similar conditions as the last, and at 3940, 59–70 fathoms, on a bottom of white sand and broken shells.

Type no. 5211, U. S. National Museum. A specimen 55 mm. long, but incomplete posteriorly, from station 3850.

Eunice bilobata, new species.

Prostomium deeply bilobed, though its precise form is difficult to determine owing to distortion produced by the protrusion of the pharynx and jaw apparatus. Body grayish in color, with a marked iridescence, all parapodia and gills light brown (in alcohol). Tip of dorsal cirrus white, with a subterminal band of dark brown. Tentacles and cirri show no trace of articulations. Median tentacle extends to eighth somite, though possibly not entire in the single specimen. Inner lateral about equal in length to median. Outer lateral arise close to inner lateral, about four-fifths the length of latter and more slender. Eyes difficult to see, situated between bases of outer and inner lateral tentacles. Tentacular cirri extend to anterior end of prostomium, their ends colored like dorsal cirri of parapodia. All cirri much wrinkled, but with no trace of articulations.

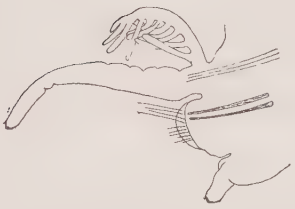

FIG. 47.

FIG. 48.

Eunice bilobata, new species. (47) Seventh parapodium, ×11. (48) Ventral seta, × 180.

Mandibles flattened and thin at their ends, united with one another by a very narrow crosspiece on the concave median edge. Maxillæ flattened at their bases, their outer ends cylindrical, smooth, and uniformly curved. Right and left dental plates each with 5 teeth. Right lateral paired plate with 10 teeth, left lateral with 7. Left unpaired plate with 3 teeth. A single accessory plate with acute apex on either side. Dental apparatus brown in color, this being very dark in the maxillæ and lighter in the other parts. Tips of teeth on lateral plates white.

Branchiæ begin on seventh parapodium, each with main axis and 9 lateral branches (fig. 47). On somite 34 there are 15 or 16 of these, one having bifurcated tips. On a somite from farther back in the body (taken from a fragment so that its precise position could not be determined) the main axis was much larger than the dorsal cirrus, and its diameter great in proportion to those of the 18 small branches which were situated along its inner face.

Parapodium with two large, black aciculæ extending into the bases of the setæ. A bundle of finer, sharp-pointed aciculæ extend into the dorsal cirrus, and in somites behind the twentieth a third group protrudes from the surface just above the ventral cirrus. In one parapodium there was only one of these, in another there were three. Ventral cirrus with swollen base, forming a prominent swelling on ventral surface, and a smaller, rounded, terminal portion.

Dorsal setæ long, fine-pointed, curving gently toward the end. Ventral setæ compound, basal portion broader at tip than at base. Terminal portion short, narrower than apex of basal, with a terminal and a subterminal tooth. "Guard" not continued around end, finely denticulated along the edge (fig. 48). Anteriorly each parapodium with a rounded lobe which projects beyond the bases of the setæ.

The collection contained fragments of a single specimen. One fragment of the anterior end of the body consisted of head and 35 somites. Length, 19 mm.; breadth, exclusive of parapodia, 5.5 mm.

Collected at station 3871, at a depth of 13.43 fathoms on bottom of fine white sand. Type no. 5212, U. S. National Museum.

Eunice nicidioformis, new species.

Body narrow in proportion to length. Largest specimen contained 100 somites, was 43 mm. long, and 2.5 mm. wide without the parapodia. There is a slight increase in width from the first to the sixth somite, while posterior to this the body tapers gradually to the end. Color in alcohol, light brownish yellow, with marked iridescence. Anterior somites show a pearly luster, most noticeable in somite 6.

Prostomium rounded, with median frontal indentation (fig. 49). Median tentacle reaches to fifteenth somite, inner laterals to tenth, outer laterals only to third. Tentacular cirri extend to

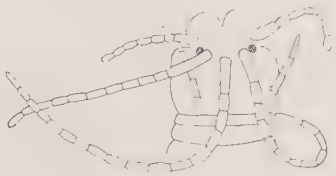

FIG. 49.

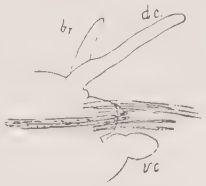

FIG. 50.

FIG. 51.

Eunice nicidioformis, new species. (49) Head, × 5.5. (50) Anterior parapodium, × 56; *d. c.*, dorsal cirrus; *br.*, gill. (51) Ventral seta, × 183.

anterior face of outer lateral tentacles. All tentacles and cirri articulated, this being most noticeable in the outer laterals, which are almost moniliform. Anal cirri two pairs, dorsal ones long, articulated, ventral much shorter, pointed.

Maxillæ light brown, apex cylindrical, gently curved. Great dental plates each with 6 teeth, margins brown, lateral portions white; left paired plate with 7 teeth, left unpaired with 5; right paired with 9. All plates colored only on their inner margins.

Gills at first sight seem to be absent, whence the specific name. On some anterior appendages, however, is a very small gill (fig. 50). On largest, sexually mature individual, these begin on somite 7 and end on somite 37.

Parapodium with long unsegmented dorsal cirrus (fig. 50). Ventral cirrus proportionately rather large. Simple setæ long, flattened, curving gently toward distal end; apex sharp-pointed. Compound setæ rather slender, basal portion with distal end slightly broader than the terminal portion (fig. 51), latter with a terminal and a subterminal tooth, and a "guard" extending slightly beyond the former. In anterior parapodia are two large black aciculæ. Posteriorly there may appear a third aciculum, ending just dorsal to the ventral cirrus. Parapodia with a rounded posterior lobe extending beyond the bases of the setæ.

Collected at station 4077, 99-106 fathoms, on bottom of fine coral sand and foraminifera; from station 4098, 95-152 fathoms, with a bottom essentially like the former, and from station 4101, 143 fathoms, on coral sand and foraminifera. Type no. 5213, U. S. National Museum, a specimen 47 mm. long, collected at station 4098.

Eunice biannulata Moore.

Eunice biannulata Moore, New Polychæta from California, Proc. Acad. Nat. Sci. Philadelphia, vol. LVI, 1904, p. 484.

These show very considerable differences from the specimens described by Moore under the above name. Closer examination shows, however, that in the character of setæ and jaws, and in mode of origin of gills, they agree very closely with his description. In one the head agreed with the type, while in the others there had been so much contraction due to the preservation that the precise character of the tentacular annulations was hard to determine. The main differences are in size, the largest having a length of 190 mm. and a width of 10 mm.

Collected from station 4551, vicinity of Monterey Bay, California.

Eunice sp.

From stations 4015 and 3822 were collected members of this genus, those from the former station too much injured for identification, the latter evidently an immature form.

Genus LUMBRICONEREIS Blainville.

Lumbriconereis grandis, new species.

A rather large species, 3.5 mm. in diameter at the prostomium, 5 mm. at somite 35. No entire specimens were in the collection, but some fragments of the posterior end which were preserved were scarcely more than half as broad as the anterior portions.

Head (fig. 52) bluntly rounded, length about equal to breadth. No eyes were visible. The head in each case was bent dorsally, owing to the position assumed by the animal when killed. When bent back to its proper position, there appears on either side a shallow depression at posterior edge of head.

FIG. 52.

FIG. 53.

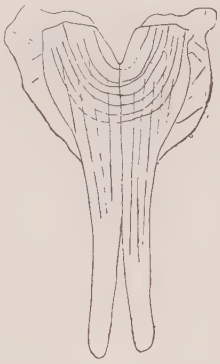

FIG. 54.

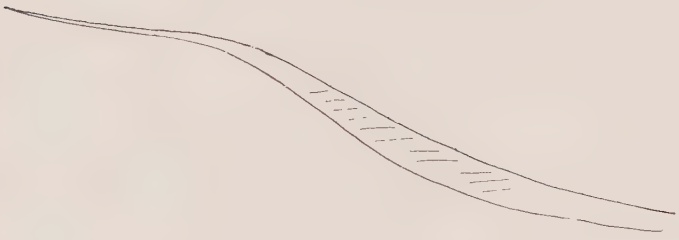

FIG. 55.

FIG. 56.

Lumbriconereis grandis, new species. (52) Head, ×2.5. (53) Right maxillary apparatus, ×9; *ac,* accessory plates. (54) Mandible, ×9. (55) Seta, ×183. (56) Hooked seta, 183.

In the jaw apparatus each lateral plate has 4 teeth (fig. 53); anteriorly on either side are two smaller plates, roughly triangular in form, with toothed apex pointing toward median line. The whole is surrounded by thin chitinous plate (not shown in figure), in which at two points are seen darker patches (accessory plates, *ac* fig. 53). All mouth parts very dark brown, mandibles a very little lighter in color than maxillæ, the two halves separated posteriorly for more than half their length. Anteriorly a wing of thin, transparent chitin surrounds the end of the mandible (fig. 54).

Setæ arranged in vertical rows in each parapodium. Base of seta dark brown, apex lighter, this difference in color very noticeable in entire annelid.

Parapodium with anterior and posterior lobes, the posterior slightly the longer, and with a dorsal, acute tip; this structure less noticeable in anterior than in posterior somites. Toward posterior end whole parapodium becomes very prominent, and distinction between it and body is much sharper than anteriorly. Anterior and posterior lobes about as long as basal portion of parapodium. Setæ of two

kinds, in anterior somites stalk long, cylindrical, terminal portion flattened, bent, and with acute apex (fig. 55); posteriorly stout, hooked setæ, with denticulated end surrounded by a "guard" (fig. 56). There may be a number of stout, very dark aciculæ in each parapodium, extending to a considerable distance beyond its end. The end is rounded and more transparent, having a reddish color by transmitted light.

In many respects this form agrees with the description of *L. japonica* Marenzeller, as given by McIntosh (Challenger Reports, vol. XII, p. 243). It differs mainly in the character of the jaws, and in the absence of compound setæ. It is possible that the latter may have been lost.

Fragments of 4 specimens were collected at station 4132, 257–312 fathoms, on a bottom of fine gray sand and mud, and from 4027, 319 fathoms, with a bottom similar to the former.

Type no. 5214, U. S. National Museum. Length of first 50 somites about 15 mm.; collected at station 4027.

Lumbriconereis minuta, new species.

Length 20 mm., breadth 2 mm. Possibly an immature form.

Head moderately elongated, about as wide as long, with blunt apex. No eyes. Maxillary apparatus black, the maxillæ gently curved, rather stout. Dental plate on right with 5 teeth, on left with 4. Anterior to these are various accessory plates, which in the preparation showed as in figure 57. As these were more or less injured in removing they probably do not accurately represent the natural condition.

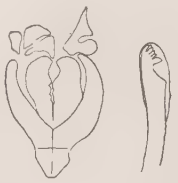

Fig. 57. Fig. 58.

Lumbriconereis minuta, new species. (57) Jaw, × 57. (58) Seta, × 280.

Parapodium uniramous with posterior lip longer than anterior. Setæ few in number, of 2 kinds; one stout, with one large and a series of smaller hooks, the whole surrounded by a translucent "guard" (fig. 58); the second form very long, slender, tapering to apex with a wing along edge of distal two-thirds, winged portion bent so as to form an angle with basal portion.

Collected at station 4083, 238–253 fathoms, on a bottom of fine gray sand. Type no. 5215 U. S. National Museum. A specimen 20 mm. long.

Genus ARABELLA (**Grube**) Ehlers.

Arabella iridescens, new species.

An incomplete specimen, about 75 mm. long. Width of first somite, 2 mm., toward posterior end of fragment, 4 mm. Anterior parapodia about two-thirds length of later ones, reaching full length at about somite 16.

Head rounded, nearly as broad as first somite, length equal to first 3 somites (fig. 60).

Parapodium uniramous (fig. 59) with a long median lobe arising posterior to the setæ, and extending about half way of their length. A very small dorsal cirrus, no ventral cirrus. Most setæ had been broken. Figure 59 shows as well preserved a parapodium as I could find, with 3 intact setæ. Imbedded in the parapodium were a number of the basal portions of other setæ which had broken away. A single seta, looking as if intact, had a rounded end. Two very delicate colorless spines protruded from the parapodium just dorsal to the setæ.

Fig 59. Fig. 60. Fig. 61.

Arabella iridescens, new species. (59) Parapodium, × 23. (60) Head, × 5. (61) Seta, × 183.

Setæ (fig. 61) with basal portion cylindrical, terminal portion flattened and bent, ending in an acute point. At outer edge of bend a row of minute, sharp, denticulations.

Collected at station 3856, in 127 fathoms, on a bottom of fine sand and yellow mud. Type no. 5216, U. S. National Museum.

Arabella attenuata, new species.

Length, 90 mm. Width, without parapodia, 2.5 mm. Color in alcohol, pale yellow.

Head (fig. 62) oval lanceolate, about as long as first 2 somites. Eyes, two pairs, brown, the inner larger and more prominent than outer. Mandibles jet black except at their anterior ends, which are light brown, united for about two-fifths of their length, tapering gently to blunt point posteriorly. Right maxillæ with 4-toothed plates, increasing in size from before backward; first with 4 equal teeth, second with 5 teeth, increasing in size from before backward, third with 4 or 5 much larger teeth than occur in either of the others, fifth with 6 or 8 prominent teeth. The left maxillary plates were too badly broken to be described. A long, narrow, light-brown chitinous rod terminates the maxillæ posteriorly.

FIG. 62.—Head of *Arabella attenuata*, new species. × 9.

Parapodium of tenth foot with rudimentary cirri, with posterior lobe large, blunt, extending upward and backward. A very broad, bluntly rounded aciculum extends to some distance from apex. Setæ few in number, with broad curved end provided with a wing and tapering to an acute point. Minute serrations along wings near their basal portion. Near base of large setæ are smaller ones, differing from these mainly in size. Other parapodia essentially similar to the tenth.

Collected at station 4551, vicinity of Monterey Bay, Cal. Type no. 5217, U. S. National Museum, 90 mm. long, 2.5 mm. broad.

Genus NOTHRIA Johnston.

Nothria macrobranchiata McIntosh.

Nothria macrobranchiata McIntosh, Report Challenger Exp., vol. XII, p. 320, pl. XLI, figs. 1, 2, 3, pl. XXII A, figs. 6, 7.
Northia macrobranchiata Moore, Polychaeta from the Coastal Slope of Japan and from Kamchatka, Proc. Acad. Nat. Sci. Philadelphia, vol. LV, June, 1903, p. 445.

A number of specimens, mostly imperfect. McIntosh describes median tentacle as shorter than adjacent ones. In these specimens it was slightly longer. The left unpaired plate of the dental apparatus had 9 teeth in these specimens instead of 11, as figured by McIntosh. The branchiæ were shorter and broader than those figured by McIntosh, though the difference may have arisen, as he says, because of a difference in the condition of the blood vessels. Branchiæ in one specimen appear first on the ninth, in another on the tenth somite. In addition to setæ described by McIntosh, there is a bundle of very small "brush-shaped" setæ situated just dorsal to the base of the larger "dorsal setæ."

As noted by Moore, branchiæ extend to posterior end of body. No anal cirri were preserved in the single complete specimen of this collection. The tubes have the usual membranous foundation, and are thickly covered on the outside with small pebbles and bits of coral rock.

Collected at station 4007, 508–557 fathoms, on bottom of gray sand and foraminifera; stations 4021 and 4022, 286–399 fathoms, bottom of coral sand and foraminifera, and 4041, 382–253 fathoms, on gray mud and foraminifera.

Genus MARPHYSA De Quatrefages.

Marphysa teretiuscula (Schmarda).

Eunice teretiuscula Schmarda, Neue wirbellose Thiere, I, bd. II, p. 129, taf. 32, fig. 259.

These differ from Schmarda's description in that the gills are 3 instead of 4 branched in their greatest development.

Collected at Honolulu Reef.

Family STAUROCEPHALIDÆ.

Genus STAUROCEPHALUS Grube.

Staurocephalus australiensis McIntosh.

Staurocephalus australiensis McIntosh, Report Challenger Exp., vol. XII, p. 232, pl. XXXVI, fig. 6, pl. XVII A, figs. 9, 10.

The present collection includes two specimens, one an adult female with eggs, which retained its tentacles, the other smaller and badly mutilated. I have identified the species from McIntosh's description of the parapodia and setæ. To his description I can add the following:

Head rounded, with large anterior and small posterior eyes (fig. 63, of smaller, imperfect specimen). Antennæ slender, tapering, about three times as long as head. Palps thick at base, tapering to slender apex (fig. 64). In the preserved specimen each is tightly coiled on the side of the head. Prostomium 1 mm. broad. Peristomium 5 mm. broad. Proboscis stout, with black teeth at apex. On dorsal surface of proboscis, just below palp, a small tubercle on either side.

Peristomium five times as broad as prostomium, and about two times as long. In preserved specimen it extends on either side to anterior border of prostomium. Behind latter is a broad depressed area, with its posterior lateral angles elongated toward side of body. In the middle of this space is a small papilla which extends forward over the prostomium (*p.* fig. 64.)

FIG. 63.

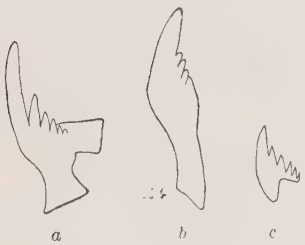

FIG. 66.

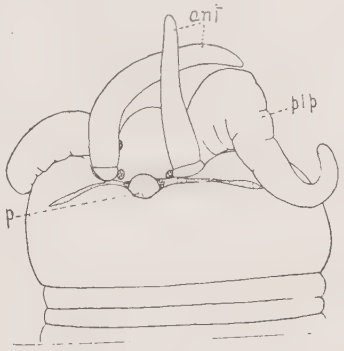

FIG. 64.

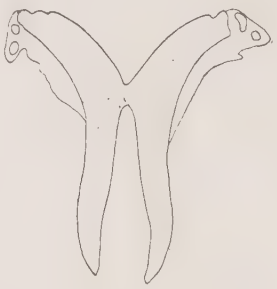

FIG. 65.

Staurocephalus australiensis. (63) Mutilated head showing eyes, × 7. (64) Entire head, × 8.5. (65) Mandibles, × 23. (66a) Tooth of inner row of maxillary apparatus, × 115. (66b) Tooth of outer row, × 115. (66c) Tooth of middle row, × 115.

Mandibles jet black (fig. 65) with minute black pieces at either side their dorsal end, imbedded in a thin translucent "wing" of material that extends down side of mandible. Maxillary apparatus of two double rows of teeth, an inner row with teeth like figure 66 a, and an outer like figure 66 b. In each row the teeth progressively diminish in size and in the number and size of their lateral denticulations from ventral toward dorsal surface. Between the two rows, on at least the right side, is one or two rows of teeth (like figure 66 c) which apparently do not reach the surface, and may be younger teeth, forming to take the place of the others.

McIntosh describes a difference between the superior and inferior setæ of the upper group, the former tapering, flattened toward the tip, the latter less attenuate, and notched at the end (see his pl. XVII A, fig. 9). In these specimens the superior setæ correspond to McIntosh's figures of the inferior ones, while the inferior setæ are shorter, broader, with bifid tip and guard, like those of terminal joints of setæ of ventral bundle. Ventral setæ as in McIntosh's description.

Collected at station 3873, 32–37 fathoms, on coral pebbles, and from station 4034, 28–14 fathoms, on fine coral sand and foraminifera.

Family GONIADIDÆ.

Genus GONIADA Audouin et Milne-Edwards.

Goniada brunnea new species.

Head elongated, conical, 4 tentacles at apex. Latter poorly preserved, but seeming to show a larger basal and smaller terminal joint. Head with about 8 annulations, though at the base the boundaries of these were hard to make out. Pharynx exserted $3\frac{1}{2}$ times as long as head (fig. 67). Pharynx with on either side a row of 14 V-shaped teeth (fig. 67). No teeth in terminal portion of pharynx.

Body well rounded anteriorly and posteriorly, with parapodia inserted on median lateral face. Anteriorly two fine longitudinal lines run along the dorsal surface, bounding, with the intersegmental grooves, a rectangular median area in each somite. Farther back a transverse line runs across the middle of each somite, uniting the two longitudinal ones, and dividing the rectangular area above mentioned into two. Still farther back the lateral lines disappear, and the transverse line bends posteriorly

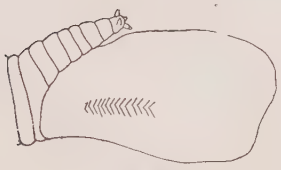

FIG. 67.

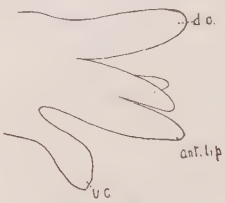

FIG. 68.

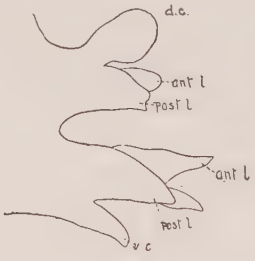

FIG. 70.

FIG. 69.

Goniada brunnea, new species. (67) Head, × 5. (68) Anterior parapodium, × 68. (69) Compound seta, × 280. (70) Posterior parapodium, × 45.

so that its ends meet the intersegmental groove, thus seeming to intercalate a small lens-shaped piece between the two somites.

First parapodium uniramous, with a single lip. Later ones, as far as the fiftieth, also uniramous, but with a trifid apex, having two ante and one post setal lobe (fig. 68). All setæ compound, basal portion deeply incised at end, terminal portion long, curved, with a broad thin "guard" along the convex edge, and a row of minute denticulations at inner edge of "guard" (fig. 69). Dorsal and ventral cirri long in proportion to breadth, rounded at end.

Behind somite 50 parapodium biramous, neuropodium agreeing in all respects with anterior parapodium, while notopodium has only a single anterior and posterior lip (fig. 70). Neuropodium with compound setæ like those in anterior somites; notopodium with long, gently curved simple setæ, with very fine denticulations along convex border.

One incomplete specimen in the collection. Color, dark olive brown; no eyes; about 100 somites; 36 mm. long and 2 mm. broad, not including the setæ.

Collected at station 4081, 202–220 fathoms, on a bottom of gray sand and foraminifera. Type no. 5218, U. S. National Museum.

Family GLYCERIDÆ.

Genus GLYCERA Savigny.

Glycera sagittariæ McIntosh.

Glycera sagittaria McIntosh, Report Challenger Exp., vol. XII, p. 347, pl. XLII, fig. 8, pl. XXII A, fig. 10.

One specimen collected at station 4083, 238–253 fathoms, on gray sand. Another, small and very poorly preserved, at station 3823, 78–222 fathoms, on fine sand and pebbles.

Family CIRRATULIDÆ.

Genus CIRRATULUS Lamarck.

Cirratulus zebuensis McIntosh.

Cirratulus zebuensis McIntosh, Report Challenger Expedition, vol. XII, p. 384.

Dorsal bristles smaller and less flattened than ventral and showing a very faint serration toward their bases. Ventral more curved and with serrations along greater part of their length. Hooks absent anteriorly, present in middle and posterior regions. They are long, slender, and only slightly curved.

Collected at Honolulu Reef and from station 3802, in tow net.

Cirratulus capensis Schmarda.

Cirratulus capensis Schmarda, Neue Wirbellose Thiere, I, bd. II, p. 56, taf. XXVII, fig. 213. McIntosh, Report Challenger Expedition, vol. XII, p. 383, pl. XXIV A, figs. 9, 10.

Fragments of much mutilated specimens from Honolulu Reef. In structure of setæ they agree with the above species. It was impossible to determine anything definite about their other characters.

Family TEREBELLIDÆ.

Genus TEREBELLA Malmgren.

Terebella parvabranchiata, new species.

Three poorly preserved specimens, to which I have given provisionally the above name. Seventeen notopodia. Dorsal setæ broadened and bent at end, apex drawn out into a fine point. Uncinus with one very large tooth, apical portion high, showing in profile as many as 6 smaller teeth (fig. 71). Seen in face view, this apical portion shows a great many small teeth, giving it the appearance of a coarse file.

FIG. 71.—Uncinus of *Terebella parvabranchiata,* new species, × 183.

Tentacles too badly injured for description.

Gills, one pair; each of a central axis with thick, simple, lateral branches, arising alternately on the two sides. Diameter of branches large as compared with the central axis, and their bases arise close together. No trace of eyes could be seen.

Tubes rather thick-walled, of dark brown sand.

Length, 35 mm.; width at anterior end, 4 mm. The possession of but one pair of gills ought perhaps to put these forms in a new genus. They were so poorly preserved, however, that possibly other gills had been lost.

Collected at station 4028, 444–478 fathoms, on bottom of gray sand and globigerina.

Type no. 5219, U. S. National Museum; length, 35 mm.

Terebella (Lanice) flabellum Baird.

Terebella flabellum Baird, Jour. Linn. Soc. London, vol. VIII, p. 157. McIntosh, Report Challenger Expedition, vol. XII, p. 446, pl. XLIX, fig. 3.

A single empty tube from station 3938, 148–163 fathoms, on bottom of white sand and broken shells.

Terebella sp.?

The collection included one fragment of a *Terebella* from Pago Pago, Samoa, too much injured for identification.

Terebella crassifilis Grube.

Terebella crassifilis Grube, Annulata Semperiana, p. 226, pl. XII, fig. 2, 1878.

Some poorly preserved specimens which agree, so far as I can determine, with Grube's description of this species in every respect except in the character of the thoracic uncini. Grube describes these with 4 teeth. In the specimens from Hawaii there are 6.

Collected at station 3834, on coral rock, sand, and shells, and from station 3876, 28 fathoms, on sand and gravel.

Terebella gracilibranchis Grube.

Terebella gracilibranchis Grube, Annulata Semperiana, p. 230, pl. XII, fig. 6, 1878.

These differ from Grube's description in that the tentacles are proportionately somewhat larger, and that the thirteenth ventral scute is much smaller than the twelfth, scutes 13–16 inclusive being very small and easily overlooked. All specimens small. Length to posterior border of twelfth scute 4 mm. Breadth of anterior region 2.5 mm. Body swollen and filled with eggs.

Genus LANICE Malmgren.

Lanice flabellum Baird.

Two imperfect specimens. I have identified them from the descriptions and figures of gills, tentacles, and setæ given by McIntosh. (Challenger Report, vol. XII, p. 446, pl. XLIX, fig. 3, pl. L, fig. 1, pl. XXVII A, fig. 22.)

Collected at station 4101, on bottom of coral sand, shells, and foraminifera, in 143 to 122 fathoms.

Lanice expansa, new species.

A single specimen in tube. Tube 3 mm. in diameter, of a membranous base, with fragments of shells, corals, etc., covering entire surface. At apex it broadens into two kidney-shaped expansions, one on either side the opening. Cylindrical portion of tube attached at hilus (fig. 83). Greatest breadth of expansion 10 mm. Length, i. e., diameter parallel to cylindrical portion, 5 mm. Along edge a row of narrow, spiny protrusions having the characteristic membranous base with particles of foreign matter on the surface. Though the body of the animal apparently filled the tube it was found in it in an inverted position, with head pointing toward base of shell. This tube answers well to the description given by McIntosh (Challenger Report, p. 448) for a *Terebella* (*Lanice*) tube, and may be of the same species, though McIntosh found no part of the animal.

Body incomplete, only about 30 somites remaining. Head with dorsally a rather prominent collar, the latter extending on either side to form a prominent lobe, ending in a blunt point. Seen from ventrally, the lobes are fused at base, their edges then overlapping for about half their length, then separate leaving a broad V-shaped space between the two sides. Edge of V not straight but with a blunt elevation about in the middle. Posterior and lateral to the collar is a smaller and less prominent lobe.

Tentacles much coiled and twisted so that number and length are not easy to determine. A groove with elevated, much wrinkled margin runs along one side of each. On either side of this groove a comparatively broad band of pigment. Thorax anteriorly a little narrower than head, widening posteriorly to about same width as head. Ventral shields broadest anteriorly, gradually narrowing to sixth somite, then uniform in size to fourteenth, when they suddenly become larger and much more prominent.

Three pairs of gills, first large, second about half size of first, third about half size of second. Each with a broad portion supporting a much branched apex.

Setigerous somites 17. Setæ long, gently curving to acute tip. Uncini in two rows, each uncinus with base prolonged into an acute point. One large tooth, with two rows of smaller teeth at apex, each row of 2 or 3 teeth. Middle tooth of upper row nearer apex than others, so that side view shows apparently more than 3 rows (fig. 84).

Type no. 5225, U. S. National Museum, collected by the *Albatross* at station 4101, on coral sand, shells, and foraminifera, in 143 to 122 fathoms.

Genus THELEPUS Malmgren.

Thelepus branchiatus, new species.

A single much mutilated specimen. Head with no trace of eyes, and bearing long deeply grooved tentacles. Branchiæ in 3 rows. In first row about 8 on a side of long cirrus-like processes, extending considerably beyond head. Those of second row equal to these in size, but fewer in number. Of third row only one, on the left side, was retained. A very small cirrus on the right side probably

corresponds to this. It is altogether probable that the difference in number of branchiæ is due to a loss of some, especially in the second and third rows.

Setæ begin on third somite, and extend through at least 30 somites; are rather short, apex with narrow, very faintly striated wing on either side. Uncini begin on somite 5, and there is only one row in each torus. Uncinus with two smaller hooks apical to large fang (fig. 85). A protrusion on the convex surface gives the uncinus a characteristic "hunch-back" appearance. Basal portion with a small knob.

The body was distended with eggs. Diameter of head, 4 mm.; of thorax, 6 mm. Length of thorax about 15 mm.

Collected at station 4101, on bottom of coral sand, shells, and foraminifera, in 143 to 122 fathoms. Type no. 5226, U. S. National Museum.

Thelepus sp.

A single much mutilated specimen, all tentacles having been lost. Gills finger-shaped processes on second, third, and fourth somites. Those of second longest, about 12 in number. Those on third about equal to these in number, but scarcely more than two-thirds as long. Those on fourth fewer in number, bearing in length about the same proportion to those on somite 3, as do these latter to those on somite 2.

Setæ on thorax slender, with curved ends. A number of irregular serrations, looking like sand deposits, appear on curved portions of setæ. Uncini with short basal portion less than half the length of the great fang, terminated by a small, rounded "button." Great fang long, curved. On either side of apex a smaller fang, about one-sixth length of larger one. Between these small fangs a median elevation, like the basal portion of the fang in shape but without the sharp point.

Collected at station 4551, vicinity of Monterey Bay, California.

Genus AMPHITRITE Müller.

Amphitrite sp.

Fragments of an *Amphitrite*, too much injured for identification, were collected from station 3865, 256–283 fathoms, on a bottom of fine volcanic sand and rock. They were contained in a membranous tube thickly covered on the outside by foraminifera shells.

Genus TEREBELLIDES.

Terebellides tentacula, new species.

Length of head and setigerous somites, 9 mm.; width, 1.5 mm. Very considerable differences are, however, to be noted in these measurements, due to different degrees of expansion. The animal lives in a thick mud tube, in which are embedded immense numbers of sponge spicules. Owing to difficulty of penetration, many of the animals inside the tube were very poorly preserved.

FIG. 72.—Uncinus of *Terebellides tentacula*, new species, × 280.

Mouth with prominent upper lip, with short tentacle-like processes at outer edge on either side, the number of these not constant.

Median tentacle very long, as long as whole anterior region of body, flat, with edges rolled so as to form a shallow longitudinal groove, much as in tentacle of *Phyllochætopterus*. Two or three much smaller lateral tentacles on either side.

Gills in a band of 8 finger-shaped processes, on dorsal surface; each gill tapering gently to blunt point at apex; smallest in center of band, largest on outer end. Bases of gills in contact with one another, though there is some indication of a double row arrangement.

Setæ of thorax long, smooth, gently tapering from a broad base to a very delicate point. Two sizes of these setæ appear, but this size difference is possibly due to age differences.

Uncini of thorax in a single row. Teeth 5 in number, increasing in size, beginning at the apex, from 1–4, the fifth being smaller than the first (fig. 72).

Abdominal somites much smaller than thoracic, with uncini like those of thorax.

Collected at station 4126, 278–743 fathoms, on gray sand and foraminifera. Type no. 5220, U. S. National Museum.

Family MALDANIDÆ.

Genus PRAXILLA Malmgren.

Praxilla sp.?

From station 3935, at a depth of 35 fathoms, on bottom of white sand, shells, and corallines, were dredged two fragments of the anterior ends of individuals of this genus. In the form of the hooked setæ these resemble *Praxilla kerguelensis* of McIntosh (Challenger Report, vol. XII, p. 405). They lack, however, the anterior collar fold on somites 2 and 3. Tube mainly composed of radiolaria.

Family SABELLIDÆ.

Genus POTAMILLA Malmgren.

Potamilla torelli Malmgren.

Potamilla torelli Malmgren, Nordiska Hafs Annulatar, p. 402, 1865; Ann. Polychaeta, p. 114, Taf. XIII, fig. 76, 1865; McIntosh, Report Challenger Expedition, vol. XII, p. 484, pl. LIII, fig. 2, pl. XXIX A, figs. 16-19.

McIntosh does not mention paired eyes, which appear on most branchiæ just behind the tip. They are usually very small, but one specimen showed two branchiæ with very prominent eyes, appearing as large, dark-brown, spherical bodies, just behind the apex of the tentacle. The bottle containing the specimen had also a tube, formed of a membranous basis, thickly covered with fragments of shells. It probably belongs with this annelid, though it seemed small for the animal accompanying it.

Collected in Honolulu harbor.

Potamilla elongata, new species.

A number of tubes, 2 mm. in diameter, containing fragments of the animals. Body very long and slender. Gills 20 mm. long, not more than 2 mm. in diameter (when rolled together, as in preserved specimen).

FIG. 73.

FIG. 74.

FIG. 75.

Potamilla elongata, new species. (73) Seta, × 280. (74) Seta, × 183. (75) Uncinus, × 250.

Thoracic setæ of two kinds, one (fig. 73) long, slender, broader at the end, with a terminal acute tip; the other (fig. 74) with shaft about equal to that of former in diameter, tapering to blunt tip, with a rounded "wing" on opposite sides of apex, uniting beyond apex and terminating in an acute tip.

Uncini with one large tooth, and crown covered with a number of smaller teeth (fig. 75).

Collected at station 3865, 256 fathoms, on bottom of fine volcanic sand, and from station 3883, 277 fathoms, on bottom of globigerina ooze.

Type no. 5221, U. S. National Museum, collected at station 3883.

Potamilla californica, new species.

A single individual, retaining only head, thorax, and a few abdominal somites. Branchiæ 20 in number, 6–8 mm. long, with very delicate side branches. Basal portion broadest in collar region, narrowing slightly near where gills are attached. Collar very narrow, with incisions above and below, with ventrally a dark transverse band on either side.

Number of thoracic somites, 8. Setæ and uncini like those of *P. elongata*. It differs from the latter species in the greater body diameter and the much shorter branchiæ.

Collected at station 4551, vicinity of Monterey Bay, California. Type no. 5222, U. S. National Museum.

Genus LAONOME Malmgren.

Laonome punctata, new species.

Body rather stout; thorax 3 mm. in diameter. Length of thorax and abdomen, 21 mm. Tentacles about 10 mm. long.

Tentacles about 25 on a side, basal portion for rather more than one-half their length a deep purple color. Rest of tentacle in irregularly alternating bands of white, yellow, and purple. Inner margin deeply fringed, very short free terminal portion.

Thoracic somites show great variation in arrangement of metameres. Through splitting of somites, the two sides rarely show an equal number of intersegmental constrictions, and consequently have an unequal number of uncinal rows, the number varying from 5–8. Ventral shields of thorax not very prominent, rectangular. A very narrow fæcal groove.

Setæ (fig. 76) long, with flattened wing, showing serrated edges. Uncini with one large tooth, and numerous finer teeth scattered over the apex of the crown (fig. 77). Uncini of thorax and of abdomen similar.

Body with numerous minute purple spots scattered irregularly over its entire surface, forming a dense mass just posterior to the collar. Collar narrow, with a prominent incision dorsally and ventrally.

A prominent spot on posterior ventral face of each parapodium.

The animal lives in a thick-walled tube, covered on the outside with a layer of brown mud.

Fig. 76. Fig. 77.

Laonome punctata, new species. (76) Seta, × 280. (77) Uncinus, × 280.

Collected at Puata Bay and at Waialea, Oahu. Type no. 5223, U. S. National Museum. Length of thorax and abdomen, about 21 mm.; collected at Waialea, Oahu.

Family SERPULIDÆ.

Genus POMATOCERUS Phillipi.

Pomatocerus strigiceps Mörch.

Pomatocerus strigiceps Mörch, Naturhistorik Tidsschrift, Kjøbenhavn, June, 1863, p. 412. McIntosh, Report Challenger Expedition, v. XII, p. 520; pl. LV, figs. 3, 4; pl. XXI A, figs. 26, 27, 28.

Two specimens, somewhat broader than those described by McIntosh, being nearly 6 mm. wide in the region of the collar. Each had lost its operculum, the only trace remaining being a short piece of the thick, cylindrical stalk.

Collected at stations 4031 and 4034, 14–28 fathoms, on fine coral sand, foraminifera, corals.

Genus PROTULA Risso.

Protula arafurensis? McIntosh.

Protula arafurensis McIntosh, Report Challenger Exp., vol. XII, p. 511, pl. XXXI A, figs. 17, 18.

Two specimens. Both were injured, neither retaining any portion of the abdominal region. McIntosh's specimen had lost the branchiæ, but in character of thoracic membrane and in setæ these agree with his description. Branchiæ 36–40 on a side, rising from a broad base, tightly coiled. No appreciable extent of apex devoid of lateral branches. Length of thorax of larger specimen 7 mm., of gills (contracted) 7 mm.

Fragments of calcareous tubes were found in the bottle with the specimens. It is doubtful whether they really belonged to the animal.

Collected at station 4551, in vicinity of Monterey Bay, California.

Genus VERMILIA Lamarck.

Vermilia sp.

A single shell, containing only a few fragments of the animal, too much injured for identification. Collected at station 3916, 299–330 fathoms, on bottom of gray sand and mud.

Family HERMELLIDÆ.

Genus HERMELLA.

Hermella varians Treadwell.

Hermella varians Treadwell, Polychaetous Annelids of Porto Rico, Bull. U. S. Fish Commission, vol. xx, 1900, p. 210, fig. 81.

These had a few less paleæ on either side than did the specimens from Porto Rico, and the inner row of paleæ was more often three than four on a side. The two large tentacles were easily broken, so that few individuals showed both intact. When one was gone, the other looked like a single median tentacle. Behind the tentacle on either side is a row of 3 or 4 tentacle-like processes, extending partly around the body.

Collected at station 3909, 308–322 fathoms, on a bottom of fine white sand and mud.

Genus SABELLARIA Lamarck.

Sabellaria setosa, new species.

Head truncated only in a very slightly oblique fashion, with shallow fissure dorsally and deeper one ventrally. On either side a single row of about 15 very slender paleæ, continued around a curve near ventral surface so as to form nearly a complete circle. First 2 or 3 dorsal ones short, others much longer, of uniform length throughout. Paleæ slender, tapering uniformly to apex, with what appear under low power to be very minute denticulations along both sides. Under high power (fig. 78) this appearance is seen to be due to a series of rings, the outer edge of each forming a protrusion all around the palea. These rings relatively more prominent toward apex. Interior of paleæ with numerous fine parallel longitudinal lines.

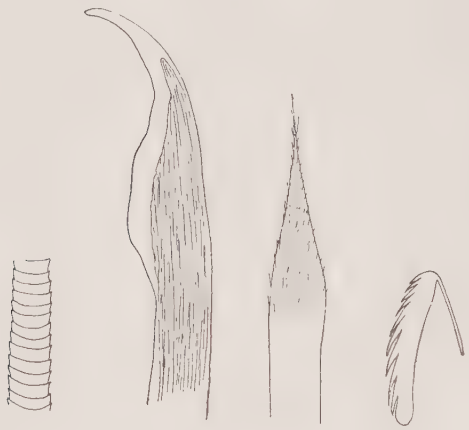

Fig. 78. Fig. 79. Fig. 80. Fig. 81.

Sabellaria setosa, new species. (78) Portion of palea, × 188. (79) Dorsal hook, × 45. (80) Seta, × 185. (81) Uncinus, × 280.

Dorsally at end of row of paleæ is on either side a row of about 6 short hooks. Each (fig. 79) has a thick central axis, curved at apex, and with a broad, thin wing on curved surface. Axial portion marked with large numbers of fine longitudinal lines.

On outer side of head near bases of paleæ is on either side a row of slender, finger-shaped cirri. These may differ in size, apparently a result of unequal contraction. Dorsally each row bends around so that a few cirri are found between the two rows of dorsal hooks.

Mouth with two large palps, crenulated at the edges. Behind these on either side a broad, rounded lobe. Behind this two transverse rows of cirri, 2 or 3 in a row, the anterior larger than the posterior, most dorsally placed cirrus of posterior row lying close to base of first gill. A narrow, rounded, and rather prominent lower lip lies just posterior to the mouth.

Gills eight pairs, long, narrow, gently tapering toward apex, the anterior ones largest and overlapping in dorsal middle line, posterior ones smaller. Along both edges of each gill are series of little fleshy protrusions of its wall.

Somites 2 to 5 carry dorsally a row of short, stout setæ with broad pointed ends (fig 80). Whole surface of expansion covered with short, sharp spines. Alternating with these in each row are very long, delicate hair-like setæ. On sixth somite these setæ disappear and a row of uncini takes their place. Each uncinus with numerous sharp spines along one face, looking in profile (fig. 81) like a single row of very sharp spines. Some show a rod attached at one end as in figure, while in others it is attached at the opposite end. I am unable to say whether there is any regularity in the distribution of these two forms. These rows of uncini are found in as many somites as were preserved in any of my specimens. Ventrally in each somite is a tuft of very long, hair-like setæ.

The posterior body region was not preserved in any of the specimens.

Tube very thick walled, composed almost entirely of shells of foraminifera.

Length of head and 12 anterior somites 16 mm. Width of anterior region 3.5 mm. Color (in alcohol) light brown ventrally, dark brown dorsally. Palps and cirri of head very light brown. Paleæ golden yellow. Collected at station 4041, 382–253 fathoms, on bottom of gray mud and foraminifera. Type no. 5224, U. S. National Museum.

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